TRAFFIC QUARTERLY

AN INDEPENDENT JOURNAL FOR BETTER TRAFFIC

APRIL 1955

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Defining Urban Trade Areas
Economic Effects of N.Y. Thruway
Traffic Problems of Shopping Centers
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The British Floor Space Index
New Roadsides for Highways
Park-Ride in St. Louis
North Dakota's Study
School Bus Safety

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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VOLUME IX, NUMBER 2 APRIL, 1955

PRINTED BY COLUMBIA UNIVERSITY PRESS, NEW YORK, N. Y.

Traffic Quarterly

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Published quarterly by the Eno Foundation at Saugatuck, Conn., issue for April, 1955. Printed in U.S.A. Library of Congress catalog card: 50–1781.

Irresponsible Driving

LIMITED statistical data may seem to inform the public about poor driving. The data offer limited means of comparing the worst results of bad driving but provide slight information on the basic causes.

Driver is synonymous with *Driving*. We tolerate bad driving but shrink at its results. Our efforts are inconsequent with the character of our problem. We need to improve our driving and the driver should be firmly convinced of our intention.

We have no criterion. A record of convictions and impressive penalties on violations would more nearly satisfy our desire and expectation toward reaching a common goal of good driving. It might awaken the public and tame our intractable drivers.

It is the quality and the character of our driving that we must improve. Good drivers are becoming bad drivers. Collectively we indiscriminately violate the basic principles of good driving. Courtesy is rare.

We ignore simple things such as judgment, road rights, practical knowledge of the characteristics, controls and condition of the car. These should have the same importance in the eyes of the law as serious offenses that grow out of them.

Responsibilities for licensing, apprehension and convictions lie in the efforts of the three important divisions that handle these matters. No one of them can effectively perform its function without the fullest understanding and cooperation of the other two. Their ultimate goal and test of their efficiency is sensible driving.

Our driving understandably has become a national problem. Driving control stems from forty-eight sources, each with sufficient authority, and pride in that authority, to issue and execute suitable and necessary measures of control.

To do so requires national judgment of public opinion and public support.

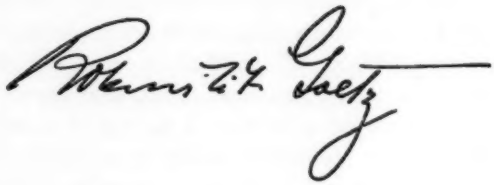
In the present heat of popular clamor and impatience for some indication of serious effort and real progress, leadership by any state will be met not with disdain but with national acclaim.

Public feeling has reached a point of disgust with lagging ineffectual methods of driver control.

Corrective measures need not be harsh but must be determined.

As a serious problem, it poses a challenge.

How shameful must the situation grow before we become a nation of irresponsible drivers without restraint, without courtesy or mercy?



Defining Urban Trade Areas

J. D. CARROLL, JR.

Mr. Carroll has since 1953 been the Director of the Detroit Metropolitan Area Traffic Study. He holds the degrees of Master of City Planning and Ph.D. from Harvard University. From 1948 to 1953 he was resident director of the University of Michigan Social Science Research Project in Flint, Michigan. He is a member of the American Institute of Planners and an affiliate member of the Institute of Traffic Engineers.

THIS article suggests a method for describing the magnitude of a city's influence on its surrounding hinterland. And a method is proposed for partitioning an entire terrain into metropolitan regions or even urban trade areas.

Let us begin by proposing that any city exerts an influence on persons and organizations outside of its boundaries. The magnitude of this influence will depend upon two things: first, the size of the city exerting the influence, and second, the distance from such city of the affected persons or organizations. This involves a simple formulation in which the power or influence of the central city is pro-

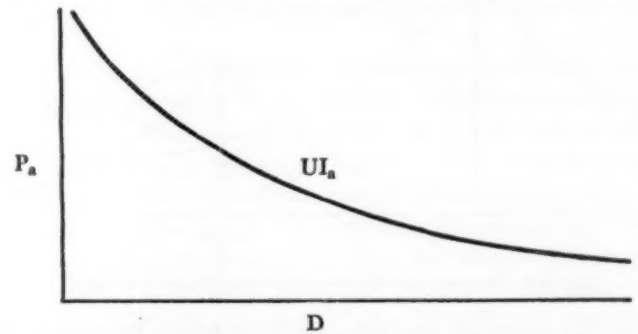


FIGURE 1. Theoretical description of magnitude of urban influence according to distance from city A

portional to the city size and varies inversely as the distance over which this influence acts. For example, a city located at point A in space will exert an influence proportional to the city size at point A,

and that influence will decline with each added increment of distance away from A.

In the above figure, as D approaches unity, UI approaches P and a formula to describe this concept of influence can be constructed as follows:

$$(1)\quad U.I_a = (K)\frac{P_a}{(f)\,D}$$

where UI_a is the attractive power of city A; P_a is the population mass of city A; D is a variable measure of distance; (f) represents the unknown rate at which increments of distance modify the urban influence; and (K) represents a constant which must be applied to provide balance to the equation.

The above describes only one city and its influence at points in a terrain. However, it is possible to introduce additional cities with interesting effect.

To Figure I, we can add a second city, B. City B's gradient of influence intercepts that of city A at points of equal magnitude yet each continues to exert influence in accordance with formula (1) beyond the point of equal magnitude even within the city limits of the other city!

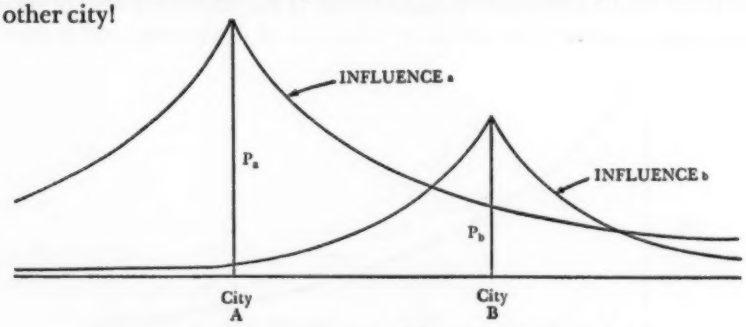


FIGURE 2. Theoretical relation of influence of city A to city B

In the same fashion, any number of cities may be considered at their proper locations in a terrain and, given the quantitative measures for the above formulation, it will be possible to divide the entire terrain into segments about each city which delimit that territory in which each city is more important (e.g. exercises stronger influence) than any other city.

As a beginning point, we assume (1) a flat terrain; (2) an urban influence proportional to city size; and (3) a constant rate of decline of influence with distance. Visualize a pole erected at each point on a map where a city is located. Each pole rises vertically a distance proportional to the size of the city it represents. These poles may be likened to tent poles from which are draped "tents of influence" representing the magnitude of each city's influence on populations located throughout the terrain. Each tent is independent of every other tent. That is, the existence of a neighboring city does not affect the shape of any city's tent. A plan view of this map can be made showing the area in which any one city's tent is highest. In this way it is possible to describe that area in which any particular city has a greater influence than competing cities.

What Is Urban Influence?

To make this concept operational, influence must be defined. Then if quantitative measures can be provided for equation (1), the concept can then be tested by actual data. To approach a definition, a city can be visualized as performing a pyramid of functions. The number and variety of functions will be proportional to the population size of the city. In all cities some functions are performed for "export" or for a hinterland population as well as for the city residents.

The smallest cities will perform a small pyramid of functions. At the base of the pyramid will be the most ubiquitous functions—perhaps friendship and visiting. Next may be grocery and drug stores and at the top will be that single function which is most specialized of all that city's functions—for example, a department store.

As cities increase in size, the pyramid of functions increases. Not only does the base enlarge but so does the height; hence with increasing size, increasingly specialized functions are performed in cities. (This will only be generally true since all cities are not exact duplicates of others and because within the nation certain locations are ideal for certain specialized activities).

The greater the *variety* and *number* of functions any city performs, the greater the probability that similar functions will not be provided in the adjacent area and therefore persons and organiza-

tions in the hinterland will make use of such special functions. Influence is then operationally defined as the extent to which population and institutions in the area surrounding any city make use of the urban functions.

To give this concept quantification, it is clear that for any hinterland population to be able to depend upon and to use specialized urban functions, interchange between the hinterland and the urban area must occur. Such interchange can occur in numerous ways. For example, radio station entertainment can be received by hinterland residents; newspaper circulation is also evidence of such relationship. Letters, telegrams and telephone calls are evidence of interchange and relatedness. Store purchases and business trips are further evidence.

To describe the effect of distance, then, some form of interaction should be measured which occurs with sufficient frequency and in sufficiently large numbers so that the effect of distance can be described by observing choices of large numbers of individuals.

The outer limit of any city's predominant influence is that point at which the magnitude of its influence on the hinterland population is equal in magnitude to the influence of a competing city. Yet, this point will necessarily describe only dominance in terms of those functions carried on in both cities which serve the hinterland population. And, according to the argument, this means those services provided by the smaller city. For example, City A in Figure 2, being larger, may have a neuropsychiatric clinic whereas City B does not. Hence there is no competition from City B for this particular urban function. To desirable the area of dominance for this particular function, it would be necessary to limit competing cities to those performing the particular function.

Formula (1) could be used for delimiting any uni-functional trade area but the boundaries would be different because of the limited competitors and furthermore, additional variables become increasingly important as specific functions are isolated. For example, trade areas for department stores might find cities themselves being subdivided into smaller intracity trade areas. Thus, the system here proposed attempts to define a composite kind of "trade area or service area" for any city, anticipating that most cities perform a

standard set of functions whose number and diversity are proportional to city population size.

Testing the Theory

To make the first empiric test of this theory, use was made of long distance telephone calls. The Michigan Bell Telephone Company made available data on the number of toll calls from fifty small places to the Michigan cities of Flint, Detroit, Lansing, Saginaw and to Bay City[1] over a ten-day period in 1946. Preliminary analysis of these calls showed that the calls per 1,000 residents from any village to each of the five cities was clearly influenced by the distance separating the place from which the call originated and the city called.

First analysis to find the effect of distance suggested that a correlation according to the following formula (2) might provide the best linear fit to the data.

(2) logarithm of calls per 1,000 population = a minus b Distance

Least squares correlations were made to test the reliability of the predictive formula 2. The fit was not bad. The average coefficient of correlation was between —.7 and —.9. However, it was clear that the lines, when seen together and plotted only for the range of distances reported, did not suggest that distance had any constant effect. Rather, the greater the distances, the lower the coefficient "b" which represents the slope of the line. (Lines of regression are shown for the range of distances for which data were available in Figure 3.) Consequently, it appeared best to try a linear equation of the order of formula

$$(3)\quad \text{Calls per 1,000 population} = \frac{a}{D^b}$$

$$\text{or } \log X = \log a - b \log Y$$

When the regression lines were fitted to the same data using formula (3), all lines had similar slopes and the exponent "b" varied from about 2.3 to 3.3. This suggested that the effect of distance was truly

1 Dunlap, Marian, "The Urban and Metropolitan Status of Flint, Michigan" University of Michigan, Social Science Research Project, Ann Arbor, June 1948.

exponential and that the exponent was between 2.3 and 3.3 Data are shown in Figure 4.

Inspection of the regression lines for the five cities suggested that

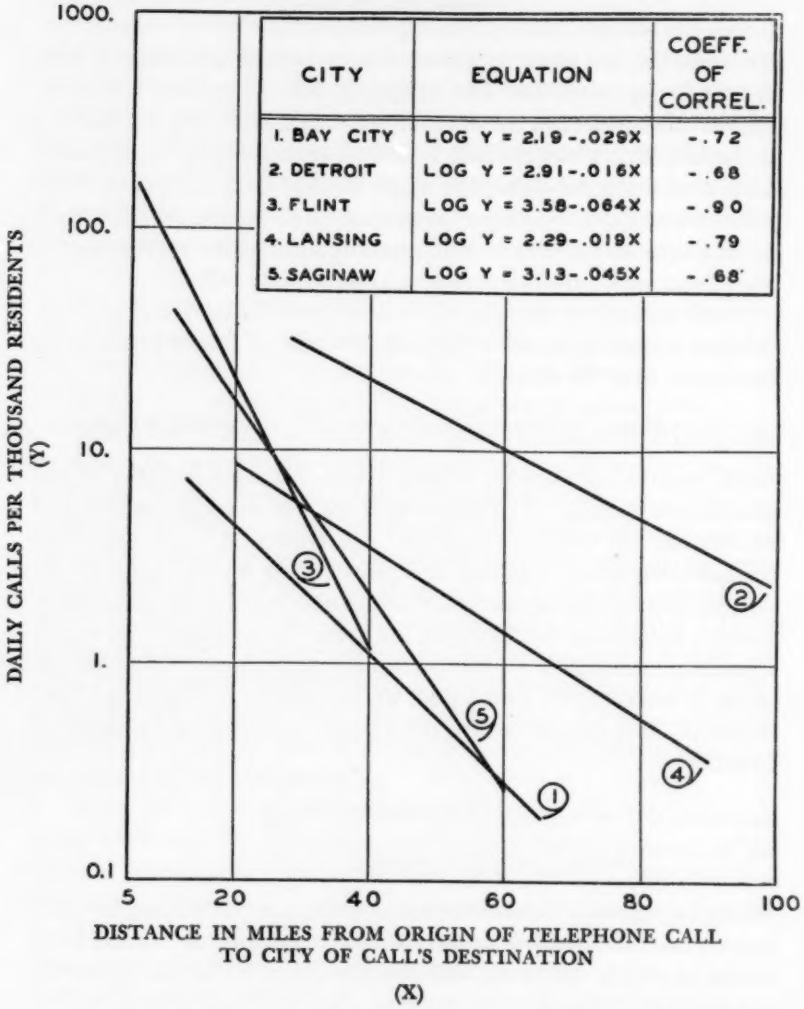


FIGURE 3. Regression lines fitted by least squares showing rate of change in frequency of telephone calls with distance for five Michigan cities (according to formula 2).

the volume of calls per person at any distance was a function of the size of the city called. If so, this would bear out the assumption that influence was proportional to city size. Thus, it was reasoned that the number of calls between any pair of cities would be proportional to the product of the two populations and inversely proportional to the distance to some power greater than two. This would be true since

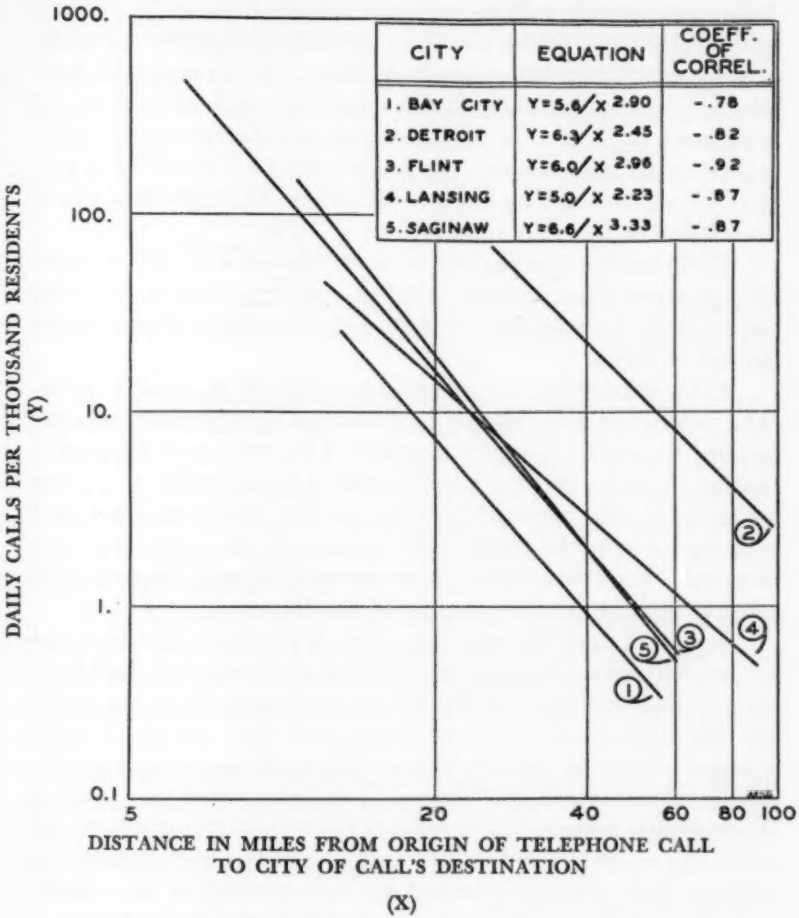


FIGURE 4. Frequency of toll telephone calls per capita to five Michigan cities from 50 small communities. (Regression lines fitted by least squares using formulas 3 and 4).

the probability of calls occurring at any distance is proportional to the number of callers times the number of callees. This is stated as Formula 4.

$$(4)\quad \frac{\text{Calls}}{Pi \cdot Pj} = \frac{a}{D^b}$$

Using this formula, calls between any pair of places can be put on a comparable basis. In this way it was possible to correlate the above telephone calls between 244 pairs of cities. The results of this combined test using formula 4, show a correlation coefficient of .89 and a negative slope of 2.62. If Lansing is excluded (being the state capital, it has influence exceeding that simply measured by its resident population on long distance telephone calls) the coefficient of correlation becomes .92 and the slope is —2.85.

These results, showing that distance effected a decline in interchange greater than its square and approaching its cube, were unexpected. Yet correlation of data for each of the cities showed slopes greater than two.

These measurements contain many sources of possible error. The number of calls were for 1946 whereas 1940 populations were applied to obtain per capita measures. The number of telephones within an exchange area would possibly have provided a better measure of call potential. Finally, airline distances were used whereas some better measure of distance might have been constructed. Therefore at best these results are only suggestive as to the effect of distance on the frequency of interchange.

In view of these shortcomings, a search was made to obtain data on intercity travel frequencies. Fortunately much work had been already done and was available. The planning and traffic division of the Michigan State Highway Department had correlated large volumes of data on intercity automobile travel from a comprehensive, state-wide survey.[2] This study found that when the place of destination was controlled, the number of trips to that city from any other city could be predicted by using formula 3 and substituting trips per unit of autos registered, for calls per unit of population.

2 "A Method of Rural Road Classification," reprint of a report submitted to the Annual Meeting of the Highway Research Board by J. Carl McMonagle, Michigan State Highway Planning and Traffic Division, January, 1950.

Curves for those cities whose ability to attract traffic volumes at a given distance was similar, were grouped and composite curves fitted. The slopes of these curves are shown below in order of the importance of the place of destination. These are of significance because of the relatively uniform effect of distance on trip volumes in all cases.

Classification of Type of City of Trip Destinations	Calculated Volume of "b" exponent for best fit
1. Neighborhood center	3.36
2. Minor market centers (small)	3.10
3. Minor market centers (large)	3.01
4. Intermediate market centers (small)	2.84
5. Intermediate market centers (large)	2.83
6. Regional centers (minor)	3.04
7. Regional centers (major)	2.84

These independent calculations serve to provide further evidence of reliability for the calculations made on frequency of telephone calls with distance.

To further supplement the above data on intercity auto travel, Mr. Iklé reports two studies made in an identical fashion. For travel to Fort Wayne, Indiana, he calculated an exponential value for distance of 2.57 using formula 3.[3] Using formula 4 above, he reports the measured effect of distance on frequency of intercity travel in the State of Washington to have an exponential value of 2.6 with a correlation coefficient of −.87.[4]

Using formula 3, the writer calculated the frequency of auto travel per unit of residential population to Detroit from one hundred places within a three hundred mile radius. These data showed a distance exponent of 2.98 and had a coefficient of correlation of −.92.[5]

The accumulated evidence, therefore, suggests that insofar as these two kinds of data reflect an accurate index of the effect of distance on a city's influence, that influence tends to diminish according to a figure approaching the cube of the distance.

[3] Iklé, Fred Charles, "Sociological Relationship of Traffic to Population and Distance," *Traffic Quarterly*, Volume VIII, No. 2, April, 1954.

[4] *Ibid.* p. 131.

[5] Data collected from roadside interviews, fall of 1953.

While all these data are consistent in suggesting an exponential effect of distance of the same magnitude, they are surprising because previous authors have posited quite different estimates of the value of the distance exponent. Zipf[6] has argued that the exponent for distance is unity and has assembled data to demonstrate this hypothesis. Reilly, in studying the patterns of retail trade attraction of Texas cities, concluded that the exponent was two.[7]

Attracting Power Proportional to Size

While differing in opinion as to the effect of distance on certain indexes of intercity activity, all authors are in general agreement that the attracting power of a city is generally proportional to its size. Thus, the single issue is the effect of distance in order to apply the tent or gravitational concept to outline urban hinterlands. This can perhaps best be done by plotting the theoretical limits of urban areas of influence according to the general hypothesis and under different assumptions of the effect of distance.

To decide the point of equal importance for any pair of cities, we can say from the original formulation,

$$(6)\quad \frac{P_i}{\overset{x}{D_i}} = \frac{P_j}{\overset{x}{D_j}} \quad \text{or} \quad D_j = \sqrt[x]{\frac{P_j}{P_i}} \cdot D_i$$

where P_i and P_j are the population masses of cities I and J, D_i and D_j are distances from the respective cities, and x represents the controversial exponent showing the effect of distance.

Regardless of the numerical exponent, the line describing all equal points of influence is always a circle with its center located on a line extending through the two competing cities and always on the far side of the smaller city. The smaller city is, of course, always inside the circle.

Knowing that a circle must be described about the smaller city, the location of this circle can be determined by using the formulas D_i plus $D_j = K_{ij}$ to determine the point between the two cities on a straight line and $D_j - D_i = K_{ij}$ to determine the farthest point on

[6] Zipf, George Kingsley, *Human Behavior and the Principle of Least Effort*, Addison Wesley Press, Cambridge, Massachusetts, 1948, especially Chapter IX.

[7] Reilly, Wm. J., "Methods for the Study of Retail Relationships," University of Texas, *Bulletin No. 2994*, November 1929.

the same line where Kij = distance from city I to city J. In effect this says that a section taken through the tents of influence of the two competing cities on a straight line would show two of the points of the circle and such line would pass through the center point of the circle as follows:

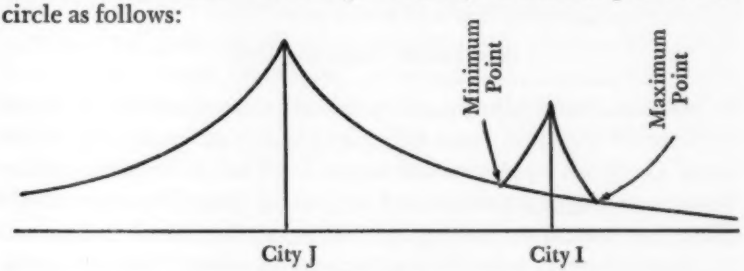


FIGURE 5

Thus, the diameter of the resultant circle of equal influence has been determined and the center located, and it is simple to plot the line of estimated equal influence.

This plan was carried out for Flint and the results shown in overlay maps describing the limits of Flint's dominant influence, using our formula and by selecting Saginaw, Lansing, Detroit, Port Huron and Bay City as competing cities (actual tests showed that Bay City and Port Huron did not affect the boundaries of Flint's area). Three different boundaries are described—one showing the exponent of distance to be unity (Zipf's proposal), another using Reilly's exponent of two, and a third using the exponent of 3 which seemed to be more closely approximated by the data already analyzed. These theoretical boundaries are plotted on a map showing the boundaries determined from independent field work by a very thorough researcher.[8]

The boundaries of Flint's area of influence as determined from field inspection most closely approximate the area defined when three (3) is the exponential value of distance. (Actually, for Flint, a somewhat better approximation is achieved by an exponent of 2.8).

An exponent of one provides tremendous competitive advantage to the larger cities because this exponent minimizes the effect of distance. It appears that such an exponent would give a very poor approximation of the actual situation in the Flint area.

[8] Dunlap,—*op. cit.*

The exponent of 2 seems to understate the extent of Flint's influence, whereas the exponent 3 provides a somewhat generous amount of area. This test, then, provides additional support to the theoretical model and to the empirical solutions proposed.

Additional Tests Applied

An additional test has been constructed whereby southern Michigan has been divided into areas tributary to each of twenty-one major cities. The territory about each center is delimited by using airline distances and 1950 populations of the several cities. The exponential effect of distance is assumed to be 2.8 (this, on the basis of the limited tests made, appears to be the most reasonable value). These boundaries are superimposed over a map of trade areas as determined by the Michigan State Highway Department. The agreement is quite good in general and the deviations are of substantial interest.

The theoretically determined boundaries are of course only an approximation. The assumption of a flat terrain with equal accessibility in all directions is certainly not true in any instance. Large bodies of water and other natural features should be considered in further refining these approximations since these natural barriers distort distance measures.

But natural features cannot explain all of the deviations in boundaries between the two systems. One of the unusual results is the inclusion of some of Detroit's tributary area north of Saginaw and Bay City. The formula indicates that Detroit has an interrupted hinterland. Yet numerous inquiries have supported this theoretical description. The newspapers of Flint and Saginaw have advised the writer that they tend to be outsold in this area by Detroit papers. This, they claim, is because Detroit papers have special bus service the same day into that area and the buses cater to the Detroit paper deadlines. Also maps of radio station listeners show Detroit stations as having a greater proportion of the total audience in these areas.

Likewise, the line of equal influence between Chicago and Detroit makes the western half of Michigan oriented more to Chicago than to Detroit. That this line truly indicates the split between Chicago and Detroit dominance is supported by many qualified observers who point out that east of this line one receives Detroit radio stations more clearly, but west the Chicago stations tend to dominate.

They also agree that Chicago vacationers predominate west of the line, whereas Detroiters are the predominant vacationers to the east.

This model, then, seems quite realistic in its ability to delimit that hinterland over which any one city exercises a dominant influence. And the model helps to explain and account for the interlocking relationship of all cities, yet still allow a territorial description of a hinterland. The model can be adapted to special functional hinterland description by limiting competing centers to those performing the competing function.

It is possible that a similar model or this exact model can be applied to the description of trade areas about nucleated shopping centers within the city itself or it may suggest areas in which factories have a competitive advantage in recruiting employees. Work is currently being undertaken to describe the effect of time and distance on frequency of travel within the Detroit area and attempts will be made to see whether intra-city subdivision of areas is realistic and whether it has similarities to the intercity gradients found.

The above formulation will not be profitable in predicting intercity traffic volumes because of the inelasticity of trip-making. In other words, intercity travel will not increase in proportion to the product of the growth of any pair of cities. This is true because only a limited number of trips will likely be made—not an unlimited number. Hence, the given number must be distributed according to relative opportunities.

A second caution comes from the assumption of linearity posited. Since curves are fitted only for a section of total range of distances and only for a portion of a sum of many interactions, the slopes may shift at unmeasured distances and substitutions may be made for forms of interchange. For example, telegrams may be substituted for telephone calls and letters for telegrams at increasing distances. Or, as distances diminish, walking trips may be substituted for automobile trips and at larger distances, train and airplane travel will have an increasing share of total travel volume.

Certainly additional work is needed to test and prove the usefulness of the model outlined above. This proposal is made with incomplete data because of the inherent simplicity of the formulation and because the model explains many phenomena which were not previously explained when trying to define urban and metropolitan areas.

Shopping Center Traffic Problems

WELTON BECKET

Mr. Becket heads one of the largest architectural-engineering firms in the United States. Headquartered in Los Angeles, the Becket organization currently is doing work in nineteen states and five foreign countries. One of the firm's specialties is shopping centers; the largest completed to date is Stonestown in suburban San Francisco. Current Becket shopping centers are under construction in Dallas, Philadelphia, Milwaukee, Charlotte, San Mateo, and in the Greater Los Angeles area; fourteen others are now in the planning stage. Mr. Becket's firm has done more than thirty comprehensive surveys and analyses to advise clients on the size, scope and economic feasibility of proposed shopping centers. Mr. Becket, educated in this country and at the Ecole des Beaux-Arts, Fontainebleau, France, is a Fellow of the American Institute of Architects.

AMERICA is a nation on wheels. The entire population could be put in the 55,000,000 motor vehicles available and still almost half of the cars would remain empty. Congestion on the streets and highways is a serious problem, but even more critical is the parking of these automobiles. How does their mere number affect shopping habits and relate to the shopping center movement?

The number of cars on the road is increasing much faster than curb space and off-street terminal parking facilities. This is especially true in the older, more settled parts of metropolitan areas. It is on the periphery of these urban areas that the new regional shopping centers have developed. The nearly 20,000,000 people added to the population in the 1940's and the 12,000,000 increase since that time, have upset the entire pattern of city growth in a new and challenging direction.

At least two important elements of the transportation problem, coupled with this growth, produced the modern one-stop shopping center. Element one is movement. Americans are modern nomads: a people on wheels possessing the greatest mobility known to society. They are capable of going almost anywhere by pressing an accelerator. For such a population, the regional shopping center capitalizes on the mobility trend and seeks to supply all the needs in one place and at one stop.

Element two is rest. The car in motion is one thing; the car at

rest is just as serious or more so. One of the greatest assets of the regional type center has been its capitalizing on freedom from congestion, convenient ease of automobile and pedestrian circulation, and foremost, off-street parking facilities.

The regional shopping center joins the forces of mobility and an ever-expanding population to create retail centers equivalent to the entire downtown areas of many large American cities.

New Buying Habits in 1940's

A whole new vista of a planned organization of supercenters opened in the late 1940's. It resulted from the population burst of that decade and the revolution in buying habits wrought in part by the mobile family shopping basket. The idea of the scientific, preplanned, artistically constructed regional shopping center came at the psychologically right moment. It entered with the "garden city" movement in England, with new concepts of planning commissions and with wholly new appreciation of the need to accept and provide for both customer and car.

To meet this series of changes required major alterations in merchandising techniques as well as new concepts in handling vehicular and pedestrian traffic. A shopping center must provide parking, ease of entrance, safe pedestrian avenues for local walk-ins, mass transportation stops, and preplanned control of automotive and truck movements, or face the same dilemma as most downtown districts are fighting today.

Analyzing Parking Demand

Studies of shopping centers should start with an analysis of the overall region, its topography, its basic highway patterns or possible ones, the traffic count and width of streets, the nearness to major intersections, travel time and, most important, a study of the population as to number, location, and possibilities for the future. Too often a site is selected before the market and physical analysis is made.

A study or analysis of this nature is directed mainly at finding the sales potential of any given site. When this potential is determined, the square footage of the center can be established. From this beginning, traffic of all types and kinds must be evaluated and

satisfied. The first thing needed is a method by which the demand for parking can be determined.

One method of estimating the number of automobile stalls required is called "parking ratio" which is highly controversial and complex. So many factors enter into the evaluation of the individual site—land value, traffic approaches, positioning of the various units on the land, topography of the land, skill of planning and use of the various types of circulation, methods of figuring parking area to rentable space, etc. These all boil down eventually to the question of how many dollars are to be spent for parking and how many spent for rentable space on any given piece of land, after the dollar potential of the area has been determined.

The term parking ratio is often confused within itself. For instance, the Community Builders Council uses seven car spaces per thousand square feet of gross building area for a two-to-one ratio.[1] This excludes service areas, such as boiler rooms, freight tunnels, corridors and truck docks. A three-to-one ratio in this case translates to ten cars per thousand square feet of building area. Employee parking is not mentioned in these ratios.

Many merchants refer to gross selling area versus parking area when discussing parking ratio. This would obviously increase the ratio to at least four-to-one or possibly even five-to-one.

Most methods that have come to our attention consider gross square feet of floor area without any deductions. The following list of shopping centers shows their published parking ratios:

CENTER	LOCATION	PARKING RATIO
*Broadway	Anaheim (under construction)	2.1 to 1
*Cheltenham	Philadelphia (under construction)	3.0 to 1
Evergreen Plaza	Chicago	1.45 to 1
Framingham	Boston	3.6 to 1
*Hillsdale	San Mateo (under construction)	1.1 to 1
Lakewood	Lakewood (not completed)	4.6 to 1
Mondawmin	Baltimore	2.7 to 1
*Oak Cliff	Dallas (under construction)	3.0 to 1
Parker Square	Wichita Falls	3.2 to 1
*Stonestown	San Francisco	1.2 to 1
Westchester	Los Angeles	1.1 to 1

[1] J. Ross McKeever, "Shopping Centers: Principles and Policies," *Urban Land Institute, Inc., Technical Bulletin No. 20,* (Washington, D. C., July 1953), p. 21.

* These centers, planned and designed by Welton Becket and Associates, are based on gross parking area to gross floor area in structures.

A second method involves a unit sale factor. Two stores with exactly the same annual gross sales may vary tremendously in their requirements for offstreet parking. Store A, dealing in lower priced merchandise, will have a higher number of individual sales transactions per day than Store B, and thus needs more parking. However, Store A at the same time will probably have a faster turnover.

According to the Chamber of Commerce of the United States, a survey of eighteen cities showed that the average value of retail sales produced by a single parking space was approximately $20,000. The range was from $10,000 in Newton, Mass., to $64,000 in Modesto, California.

Studies of this nature were made for the Hillsdale Shopping Center. Formulas were set up reflecting anticipated annual gross sales, percentage of shoppers not arriving by car, car turnover, customers per car, average unit sale. Applying this formula to the Hillsdale center, the figures used were:

Anticipated annual gross sales	$35,000,000
Minimum car turnover per space	3.3
Customers per car	1.4
Customers arriving by car	50%
Average unit sale	$5.40

Conclusion: one parking space would be required for every $15,000 of the expected annual sales volume.

The turnover factor of parking spaces is woefully underestimated in some shopping center studies. Turnover per parking stall can run as high as twelve cars per day depending on the type of occupancy. Therefore, each shop or store must be analyzed separately to determine the number of stalls required. The summation of required parking spaces when placed properly on the plot designates what we call balanced parking. For a balanced center as a whole, we have found the turnover to be approximately 3.3 cars per day per stall.

There is no true rule-of-thumb that solves the problems of any one center. Parking requirements must be determined by scientific study of topography, population density of the area, mass transportation, unit sales of individual shops or stores, and location of these outlets on the plot.

In planning the parking area there are several considerations which might be placed in a miscellaneous group. The weight to be placed on each of these can only be determined by examination of the individual site.

Bus and Pedestrian Shoppers

Many developers have severely underestimated the strength of mass transit or just "missed the bus." The best of formulas is upset by the number of people who ride the buses and are walk-ins. At least three kinds of traffic are present: car, bus, walk-in. If a regional shopping center had to live off private automobile traffic alone, it would die off quickly. The ratio of private car may be high initially, then fall slowly as more buses are provided.

As an example of this, the bus traffic at Stonestown Regional Shopping Center at San Francisco has steadily increased. (Figure 3.) The buses make two stops within the site, one at the door of the Emporium department store. It has been estimated that fifty percent of the customers at Stonestown are bus or walk-in customers.

At Hillsdale, it is again estimated that after a short time of operation, fifty percent of the customers will be walk-in or will come by bus. This is not a contradiction of the view that automobiles father the shopping center; it takes all three kinds of traffic to produce a successful center.

Truck traffic is probably one of the most difficult types of traffic to handle within a regional center. The trucks should not cross pedestrian, automobile, or bus traffic if possible. The trend away from the truck tunnel, because of financing, makes the problem even more serious. Service courts strategically located can replace the truck tunnel and are often much more satisfactory. Advantageous grades, such as at Cheltenham Shopping Center at Philadelphia, can often be used to permit two levels for the stores and at the same time facilitate truck entry. (Figure 1.)

Pedestrian traffic is, of course, a prime factor within the shopping center. The question is not the negative "How far will a person walk to his car?" but rather the positive "How close can we bring the parking to the stores?" If a regional center is well planned, parking will be within 400 feet of the shops. The closer the better.

At Stonestown it was learned that parking area is more affected

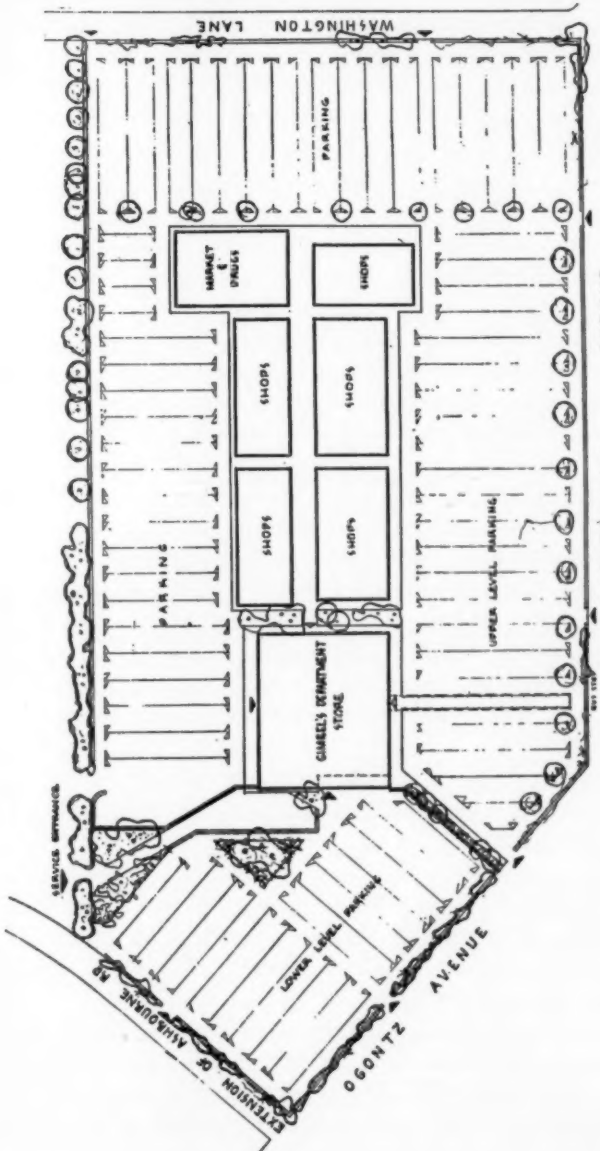


FIGURE 1. Cheltenham Shopping Center: Total cars 3850; parking ratio, 3.0 to 1.

by location in relation to point of purchase than to other factors. Arthur C. Kaufmann, executive head of Gimbel's Philadelphia store, has said that parking that is too remote from the store defeats its basic purpose. He points out that at Cheltenham Gimbel's 2,000 parking spaces surround the store in as close to perimeter parking as is possible. The whole is crowned with a light and airy and artistic appearance.[2] The better planned the shopping center, the shorter distance people will have to walk.

Too often, when the location of *employee* parking facilities is inquired about, the answer is "there" accompanied by a broad sweep of the hand in the direction of a remote area. Employee parking is a vital factor that is often miscalculated. It should be computed, designated, and reserved. To ascertain the number of spaces required, the total number of employees must be estimated. The average center has one employee for every 400 square feet of gross floor area. One out of every three employees will drive his car. The answer in the individual case will of course vary, depending on the balance of the center and public transportation.

A peculiar element in the sales traffic picture is seasonal and peak demand. Some people insist on the largest parking area possible, maintaining there can never be enough parking. Parking space must compete with all other land uses. It may be useful to place a fixed value on each parking stall, amortize it over a reasonable period of years, plus repairs and maintenance, minus sales totals reflecting non-parkers.

Other costs are for attendants, who increase the efficiency of parking up to thirty percent, multiple decking or ramping which reduces walking distance but is expensive. A point is reached where it costs more to provide a parking stall t' n that stall can bring in to merchants. Generally, it is not ne- y and frequently not possible to meet peak requirements. - not design for peak days. A balance has to be struck over the year's trade between the Christmas rush and the January doldrums.

The point is that you can overbuild parking. There can be too many empty parking spaces staring customers in the face on slack days. On the other hand, there is a psychological attraction in the hustle and bustle of a busy center which stimulates impulse buying in the shopper. No single approach to peak or slow days is possible.

2 *Retailing Daily.*

FIGURE 3. Stonestown Shopping Center, San Francisco, California.

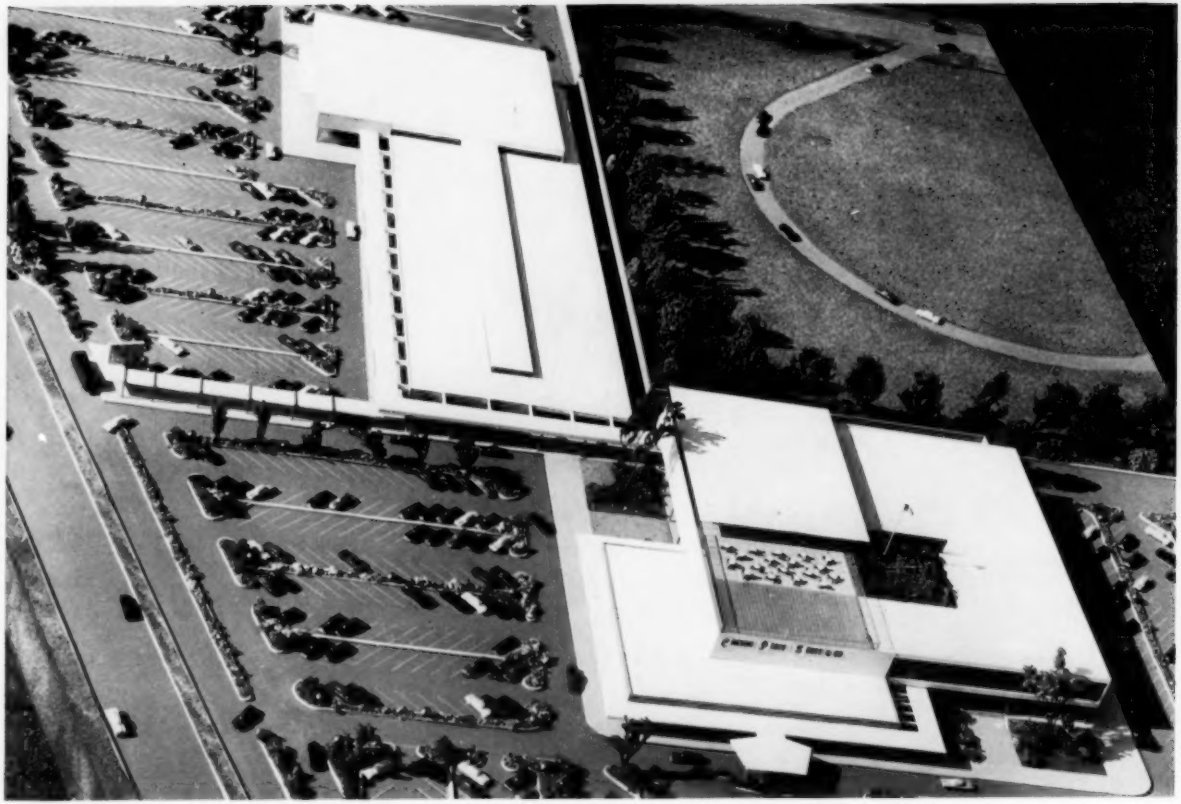


FIGURE 4. Carson, Pirie, Scott and Company, Wilmette Shopping Center, Wilmette, Illinois.

Thus far we have theorized as to the market, what shops will be supported by this potential, and factors for determining the number of spaces required. However, we must now get the customers physically from their home to the shopping center.

The American Society of Planning Officials divides the shopper's trip to a center into four stages: (1) the road he travels to get to the center; (2) the point where he leaves the road and drives into the center's grounds; (3) his search for a parking space, and (4) his walk to the stores.[3]

Accessibility Is a Crucial Index

Foremost to be considered is the roadnet leading from the trade area to the center. Sales can be captured or lost with a bump in the road. The mobile shopper does not hestitate to drive a few miles farther, if she or he has an uncongested road and convenient accessibility to the center.

An intensive study should determine the number of lanes necessary—and from which direction—to bring the potential buyers to the outlets. One should not be misled by the traffic counts of certain highways or streets. A heavy traffic count may be due to early morning and late evening travel leaving this particular avenue a utopian means of access during the shopping hours. Even more important is the fact that traffic counts will change when the shopping center opens. Thus the anticipated load becomes the prime factor.

The approach to the center itself must be well defined. Entrances should be away from major intersections and have sufficient deceleration lanes for conveniently entering the center. Sufficient study should be made to assure easy entrance and exit for the number of cars anticipated. Congestion and back-up into the major artery can be fatal. Convenience on the highways and ease of accessibility are the crucial index to capturing the available retail sales potential.

Factors in Site Design

Once at the site, where and how to park is the question. The main factors which influence parking layout are ingress and egress, site areas and dimensions, topography, and pedestrian access from car to store.

[3] *Women's Wear Daily*, April 6, 1954.

Circulation must be a continuous process of motion. There are two types of main traffic aisles within the center: one leads from the entrances and exits on the streets to the stores; the second type is belt lanes. These main aisles of course are wide enough to provide for two-way traffic. Parking directly off the main aisles leading to stores should be avoided for two reasons: it prevents automobiles from backing into the main aisle and creating congestion en route to and from stores; it facilitates loading and unloading of passengers. The belt aisles should be placed immediately surrounding the stores to permit carriage entrances, and also at the outer edge of the site. Quite often an intermediate belt aisle is required so parking lanes will not be too long. This is probably best illustrated at the Broadway Anaheim Shopping Center. (Figure 2.)

We have found that the minor aisles in most cases should be one-way. However, more caution must be used in directional indications with the one-way aisle. In general, the parking lanes should be like the spokes of a wheel leading to the stores. This provides easy access for the motorist after leaving his car to go to the shops.

The idea of using a simple angle is based on the turning radius of cars, presence of women drivers, and the desire to make parking virtually trouble-free. Certain angles mean a loss in space but a gain in convenience. In general, the area required per car is from 300 to 400 square feet depending mainly on topography and layout. The most convenient angle for self-parking runs from 45 degrees to 60 degrees.

Overlapping and interlocking patterns are possible. The continued increase in length and width of cars calls for the greatest care in determining aisle and space widths. Avoid parking on sloping areas. Frequently, the necessary slope of parking lots will determine the direction of the parking lanes in order to park cars across the prevailing slope rather than parallel to it.

One item that is often overlooked and underestimated in actual value in the sense of dollar return, is landscaping. Carson, Pirie, Scott and Company, in their Wilmette Shopping Center plan to enhance the project with ample landscaping contributing to leisurely shopping atmosphere. (Figure 4.) Too many times, in an eagerness to produce a space and dollar saving solution to a traffic problem, landscaping is completely omitted. The result is a vast cold field of black asphalt paving.

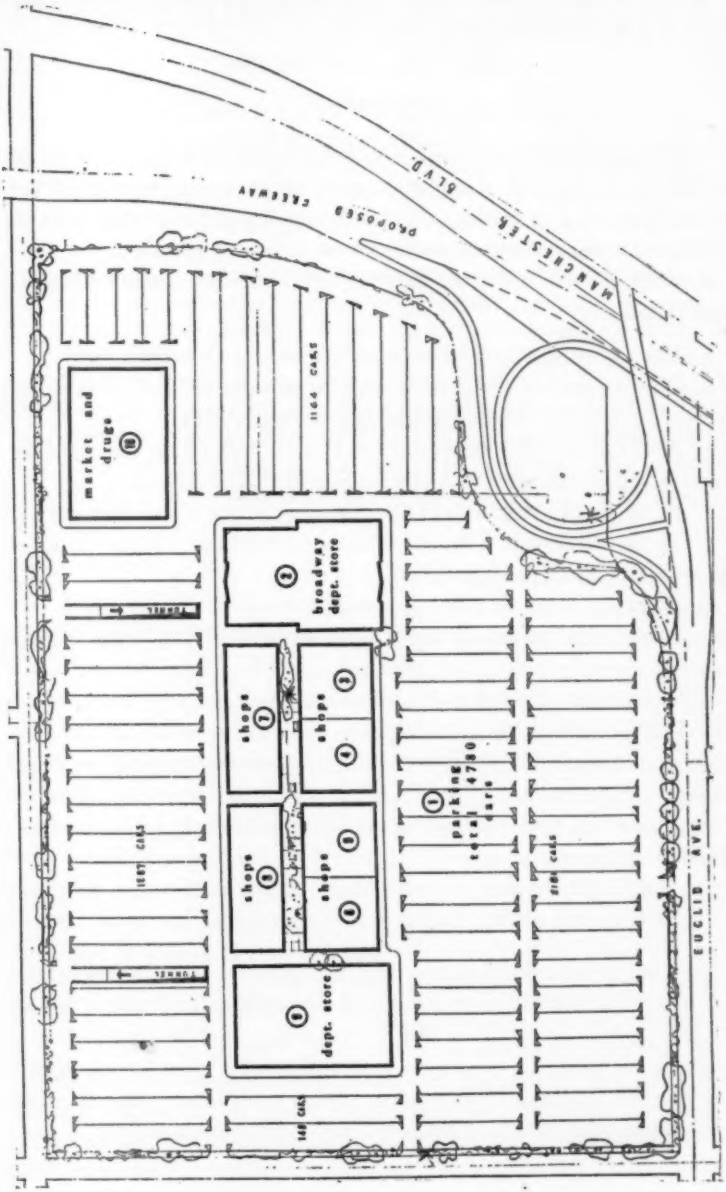


FIGURE 2. Broadway Anaheim Shopping Center: Total cars, 4780.

A sound, well-rounded inter-roadnet system can be the very life blood of a regional shopping center.

Conclusions

The criteria for determining the how and wherefore of traffic to be handled in a regional shopping center must begin with a survey and analysis of the market area and blend precisely with a multiplicity of traffic factors to attain a well-rounded solution.

A check-list of required items for consideration could be briefly listed as follows:

1. Site potential—available retail dollars for the site.
2. Gross square feet of floor area in structures—includes store, service, truck dock, receiving and maintenance areas.
3. Analysis of various retail outlets in regard to automobile turnover, sales volume, unit sale, and gross square footage.
4. Number of vehicles and the direction from which they come.
5. Meticulous regard for movement of customers from automobiles, public transit, and walk-ins.
6. Walking distance from parking place to store.
7. Integration of major and minor aisles and periphery access lanes.
8. Separation of truck and customer traffic.
9. Planned employee parking.
10. Consideration of economic factors when planning for peak parking.
11. Location and balance of parking according to occupancy requirements.
12. Angle and width of stalls designed for maximum number with regard to ease of circulation and topography.

No one site has all the necessary attributes to make it completely ideal. Each site is unique in itself and presents an individual problem. But through careful, scientific planning and by evaluating a multitude of interrelated items, a sound master plan for development can be produced. The local traffic consultant who is well versed in his field can be of infinite assistance to the architect.

New Roadsides for Highways

NELSON MILLER WELLS

Mr. Wells has been director of the Landscape Bureau of the New York State Department of Public Works since July, 1945. Formerly he was employed for fifteen years by Olmsted Brothers, landscape architects, Brookline, Massachusetts. For three and a half years he was chief planting designer for the Department of Parks, City of New York, and for seven years landscape consultant for Cornell University in planning "The Cornell Plantations." He is a member of the corporation of the New York Botanical Garden, a member of the Highway Research Board committee on roadside development, and past president of the City Gardens Club of New York City. Mr. Wells holds a professional landscape architect's license from the state of California. His professional associations include membership in the American Society of Landscape Architecture, American Planning and Civic Association, American Association of State Highway Officials, Highway Officials of the North Atlantic States and the New York State Association of Highway Engineers.

SHORTLY before 1900 a system of highways was planned and built near the city of Boston as part of the development of several large public reservations. This coincided with the earliest use of automobiles and became a forerunner of the development of parkways as we know them today. The first complete parkway system was opened about twenty-five years later in the vicinity of New York City. Its design was based on a group of principles for creating pleasure driveways within a self-contained and elongated park. In the succeeding thirty-five years many features evolved for parkways have been incorporated in general highway development and it is probable that others, particularly those relating to roadsides, will be further accepted as time goes on.

Good highway design of course begins with a proper location adapted to the existing topography. It continues through a range of features—the relationship between gradients and curvatures, the proportions to be shown in the cross sections, and the selection of materials for foundations, pavements and shoulders. The safety of a highway, however, its maintenance, and the significant impressions it creates on users, are influenced to a considerable extent by the land forms and vegetation that occur along the sides of the traveled way.

It is interesting to contrast two extremes in the construction of transportation facilities. The era of railroad building, which preceded our great highway program, employed long tangents and flat grades that resulted in extensive cut and fill slopes. These slopes regardless of their height or extent were projected across the countryside with the regularity of a template drawn through a cake of butter. Their precision was the pride of construction engineers.

At the other extreme was the design of early parkways. Slow speeds of vehicles in those days permitted small radius curves in the alignment and an easy blending of these curves to the land formations. One purpose was to enhance the scenery for the motorist. The pavement was located near the center of a wide right-of-way and all parts of the cross section were developed as a park-like unit. Well-defined shoulders with mowed grass were a natural and easy transition between pavement and adjacent natural ground forms and vegetation.

When highways were subjected to the great increase of traffic and the comparatively high speeds of the 1920's, the railroads provided a ready model for highway designers. As a result many roads were built with curve and tangent alignment and rigid grading forms like the railroads. The principle of adapting the road to larger land forms and developing the roadsides as employed on parkways was not so readily accepted.

In view of the forthcoming large-scale highway building program it is timely to call attention again to the advantages of securing points of view from a group of designers. Those especially interested in highway traffic needs, soil mechanics, construction materials and highway operations often collaborate with other designing engineers in achieving the best highways. Frequently also a landscape architect's point of view can contribute to such matters as grading, erosion control and planting, or highway location and controlled access, any one of which may benefit the development from the earliest stages of land acquisition to the final maintenance practices.

Turf Road Shoulders Cost Less

Prejudice against turf-covered shoulders has grown up over a long period. Grass and soft earth have been so closely related in reality

that most drivers instinctively keep away from the edge of a pavement where grass occurs. The green effect is desirable however as a color contrast to the pavement and as the foreground for views from the highway. Almost everyone takes pleasure in looking at a well-grown and well-kept area of turf. Contrary to popular belief, turf can be grown on a road shoulder which has been constructed to be stable and it can be maintained if the pavement is wide enough to accommodate the traffic and it receives only occasional use.

The American Association of State Highway Officials has recommended a gradation of gravel which can be used to produce stability. It contains between 10 percent and 20 percent of silt, or silt and clay, which is a quality that also permits the growth of grass. Grass can be successfully grown on a soil having as little as 5 percent passing the 200-mesh sieve, although up to 20 percent the gravel may loose its nutrients through leaching and the grass may require maintenance fertilizing. The addition of topsoil to provide an organic element is not desirable because it may too greatly increase the portion of fines for stability, and organic material has been proved unnecessary for the growth of grass. The shoulder must of course be adequately drained to remain stable and the turf will require at least as much moisture as normally occurs in the northeastern states.

Tests reported to the Highway Research Board by a committee investigating the growth of grass on stable aggregate materials indicate that: soil densities are better preserved by turf than without it; a covering of turf reduces frost penetration as well as erosion from wind and water; it produces a wearing surface having shear value although there is no significant bearing value except for a light vehicle, and its cost is less than producing or maintaining any other kind of stabilized shoulder.

A turf shoulder builds up under certain conditions however—from an accumulation of materials used in controlling ice and snow and from wind-and water-borne particles. This may eventually require blading and starting the growth over again but costs are less than maintaining a gravel surface that is not protected. Perhaps the best provision against build-up of a turf shoulder is a cross slope of at least one inch to the foot. Brooming the shoulder and rolling it when it is soft are sometimes practiced to postpone the need of blading.

It is fortunate that an adequate turf can be grown and will continue to thrive on a mechanically stabilized earth shoulder because it is the most attractive shoulder surfacing and motorists could become accustomed to associating it with stability.

Surface Drainage Important

Highway designs recognize the importance of surface drainage to an increasing extent. Study is needed in each case to determine runoff volumes and ditch cross sections without overdesigning but the trend has discarded the V-shaped ditch in favor of one having a flat bottom and gently sloping side walls. The axiom that grass is the best surfacing for a ditch until it proves inadequate has great merit. Turf-covered ditches with a cross section flat enough to be moved across and broad enough to avoid a concentration of water are not apt to be cut through by erosion.

Drainageways aside from the ditches paralleling the pavement are also significant. The designer should provide for receiving all water from lands lying above the highway, caring for it while it is on public property and discharging it to lower lying lands without causing damage. This frequently means ditches to intercept surface runoff from above which would cause erosion if allowed to flow over newly graded slopes. It may also mean side ditches of sizes and frequency to reduce concentrations which might get out of bounds and cause erosion.

Unfortunately these latter drainage provisions are not always included in the construction design but improvised by maintenance forces as a repair for erosion damages. Equally unfortunate are the effort and cost in building drainageways where they carry only the rain or snow water that falls upon them.

Failures usually point to inadequate planning or faulty workmanship as in a slipshod method of laying sod. The simple fact that water flows down a slope is ignored in more instances than could be believed possible, and drainageways laid diagonally across the contours on a slope are not uncommon. If ditches are adequately designed and simulate natural ground forms the grass will act as a thatch to protect the soil and they will scarcely be recognized as drainageways.

A ditch placed above a newly graded cut slope to intercept the

water from a hillside may collect a greater volume than can be carried to its outlet. Ditches at the ends of bridges where the runoff area is large, and ditches paralleling the pavement on long grades may also receive too great a volume during peak flows. An inlet or one or more vertical gutters in succession may be necessary to drain off these ditches and in each of these cases a covering of grass has proved adequate for moderate volumes even though they may be on slopes of 45 degrees.

The use of sod is customary in all such drainageways and around inlets before grass can be established from seed, particularly where the run-off is fast or the soil is especially erodible. Usually vertical ditches leave the main ditch at approximately right angles and the modelling of their junction by deepening the trough to keep all water within bounds is therefore very important to avoid serious erosion or to lose the benefit of the ditch entirely.

Grading on Slopes

The flattening of slopes is a basic requirement in the grading of well-designed highway roadsides. Good results may be expected wherever the steepest slope does not exceed one vertical to two and one-half horizontal although the stability of the soil is a determining factor and no slope grade should exceed its natural angle of repose.

It is generally accepted that a slope as flat as one on four can be negotiated with reasonable safety by a car out of control. An embankment up to this degree of steepness therefore should not require a guide rail. Some recent analyses have demonstrated that it is more economical to flatten a one on two slope to a one on four up to a height of about nine feet than to construct a guide rail. Above this height other factors affect the ratio: the cost of the rail, its maintenance, the perpetual and complicated mowing it requires, and perhaps the acquisition of right-of-way to accommodate the fill. Even when placing embankments up to about fifteen feet in height it is desirable to consider the additional cost of a flatter slope in comparison with the benefits—less erosion, easier mowing, greater safety and better appearance for the period of years representing the life of the highway.

Grading designed to simulate natural ground forms is a logical

progression beyond merely flattening slopes in the creation of good roadsides. A critical area is the uppermost top of a cut where it meets the natural grade. An easy smoothing and rounding at the junction of the new and existing slopes is highly desirable. Numerous formulas have been used to define the proportions of this rounding but most of them are complicated and perhaps this is the reason they are so rarely used. Any method that will successfully start the rounding at about the upper third or quarter point of the length of the slope and extend outward beyond the slope intersection for a distance of at least five feet will produce satisfying proportions.

Grading the toe of a fill slope into a talus formation which produces a rounded cross section is also desirable. Rounding at the toe of cut slopes is less easily attained because of the greater excavation required and the difficulty of accomplishing the desired effects with standard grading equipment.

Decreasing the steepness of a cut or fill slope progressively as its height decreases, produces a natural and pleasing effect. The application of this principle is called "warping." It is undoubtedly the most effective element of roadside grading design but because it is somewhat difficult or time-consuming to define on plans or cross sections it is far too rarely employed.

The results of warping are an increase in the proportion of flatter grades, less likelihood of erosion, easier maintenance; and because the results resemble natural ground formations it creates a generally pleasing appearance. Fortunately these flatter grades, rounded junctions of cut and fill slopes, and flowing land formations between cuts and fills are easily obtained with heavy grading equipment. On usual highway construction it takes planning by contours to get good results. No matter how carefully the plans are thought through or delineated, the finest results in blending the grading with the natural ground forms will still depend upon sympathetic and understanding supervision at the time of construction.

Establishing Roadside Grass Cover

A general objective in modern highway construction is to have a vegetative cover wherever it can be grown on all disturbed areas. The sooner this cover is established the less erosion will occur and

the less maintenance will be required. It has been found that minimum methods of seed bed preparation, and seeding and fertilizing without incorporation or rolling will produce a cover of grass on nearly all kinds of soil encountered in the northeastern states particularly if a mulch of hay or straw is used. Also, by managing its maintenance thereafter, the character of a turf which is merely adequate for erosion control can be changed to a luxriant greensward.

Along parkways, and especially where continuous screen plantings occur it is customary to see the grass mowed in relation to the limits of planting. Lawn areas drop back into bays between projecting masses of planting with an interesting variation in effects and on a scale related to the speed of the traffic.

On other classes of highways such as freeways and thruways which have wide rights-of-way in rural areas but no continuous screen of planting it may be possible to define the limits of mowing in relation to the neighboring countryside. Landscape effects are similar to those on the parkway but in scale with speeds of fifty miles an hour or more. In this case the face of a woodland, the hedgerows around fields or broad units of swamp-lands are the contrasting open and closed-in effects.

Thus where cultivated fields are adjacent to the highway it would be appropriate to continue the neatness of the character of the fields to the edge of the pavement by mowing the entire right of way. When the background scenery is composed of abandoned pastures or other uncultivated land the mowing needs only to extend beyond the limits of the shoulders except perhaps to keep certain drainageways open. Thus everything beyond the road shoulders would be of a similar character and even the bounds of the public property would be scarcely discernible.

Aside from the pleasant effects of such large scale landscape treatment the saving in mowing cost has been as much as 40 percent in several measured areas. Figure 1 shows an example of this pattern of mowing.

Roadside Planting and Safety

It has long been a mistaken concept that "roadside development" meant "roadside planting." An evaluation of the elements comprising a safe and attractive highway show that planting may be

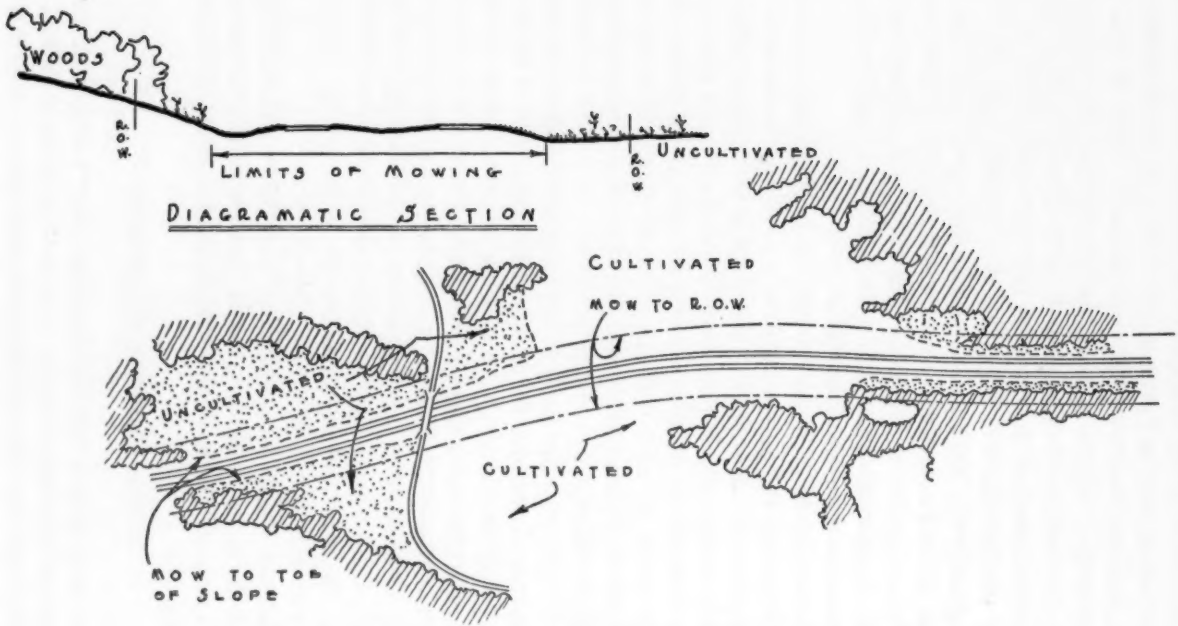


FIGURE 1. Diagram to show limits of mowing in relation to nearby land use.

important only in particular situations. Extensive plantings to include trees, shrubs and groundcovers for example may be important along an urban parkway but may not be justified in certain rural areas. In the majority of situations large and small growing trees will provide the effects desired, and large growing trees alone will furnish the greatest value over the longest period of time in nearly all highway developments.

It is important to analyze and appraise the extent and location of plant growth along a highway in an overall manner. This can be done from air photographs to gain perspective. In every case, whether trees exist or new plantings are being considered the fundamental question should be, "Does the plant growth represent a safety hazard and if not, does it serve a functional purpose?"

Trees too close to the pavement or interfering with sight distance should not be retained. No sentiment nor enthusiasm for trees should influence this decision. The need of keeping trees set back from the edge of the pavement varies according to the kind of highway and its traffic. Where a curb exists in an urban area it may be assumed that speeds will not exceed thirty miles an hour and tree trunks may be permitted as close as three and a half or four feet from the curb. As traffic volumes and speeds increase, the width of the cross section and the set-back of trees may both be correspondingly increased. The distance of set-back would be further affected by cut or fill slopes as suggested in Figure 2 for a classification of highways based on traffic volumes.

Trees which shade the pavement and cause an icy condition, or cause snow to drift on the pavement, or which might fall upon the pavement because of age or other reason, should of course be removed also. If not objectionable, they may be appraised as providing a welcome shade, framing a vista or screening an undesirable view. Where hedgerows or woodlands occur along the roadsides, removing undesirable growth to benefit and feature the desirable remaining growth can produce landscape qualities of greater interest than any man-made planting effects. Only in recent years has this technique of forest management for aesthetic effects been applied extensively to the benefit of highway roadsides.

The purpose which trees and shrubs serve is largely related to the kind of highway. Parkways are designed for pleasure cars travel-

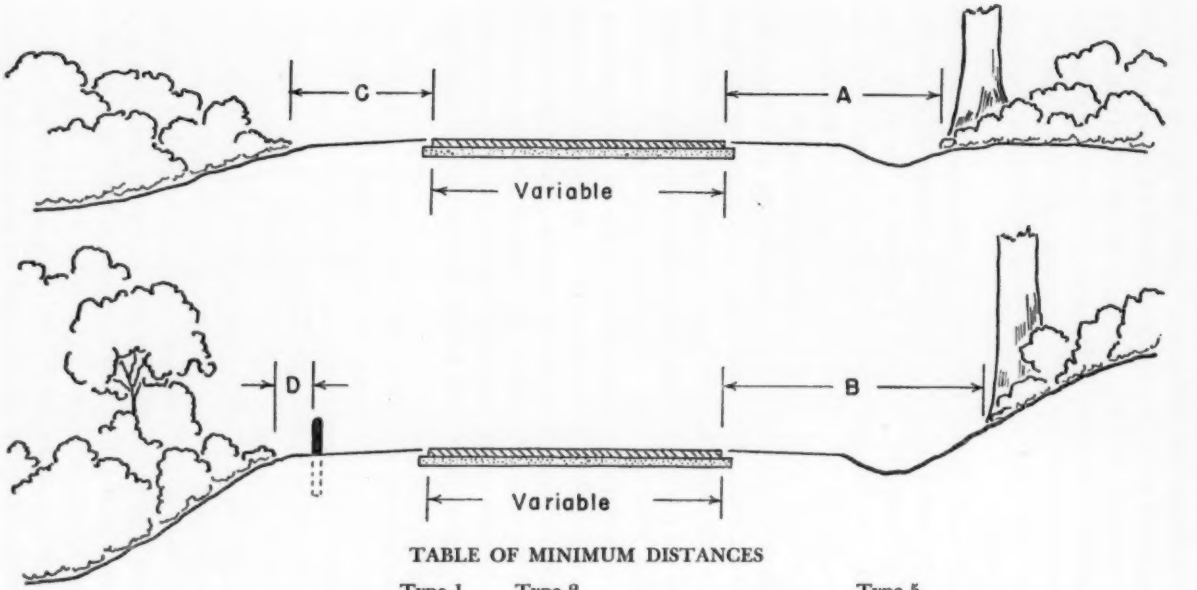


TABLE OF MINIMUM DISTANCES

Section	Type 1 4-6 lane + divided	Type 2 4-6 lane solid	Type 3 3 lane	Type 4 2 lane	Type 5 2 lane light
A – Level	20′	18′	15′	14′	10′
B – Cut	28′	25′	24′	22′	18′
C – Fill	16′	14′	12′	12′	8′

D – Fill with a guard rail – One mower width or 3′ minimum.

FIGURE 2. Vegetation in relation to highway cross section where no sight distance is involved.

ing at moderately slow speeds where the immediate surroundings can be seen in detail and detailed landscape effects are appropriate. They may pass through heavily built-up areas and it is important that such routes be well insulated from their surroundings. The motorist's attention should not be diverted by miscellaneous scenery.

There is always the drone of traffic also and studies are progressing to measure the kinds of traffic noises and determine whether depressed highway sections, walls, embankments or plantings and what kind of planting will best shut out these noises. The presence or absence of a screen as part of the roadside development may mean the difference between injuring a neighborhood or so enhancing it that property values are increased. In other cases the city may be so heavily built up that it may be possible to have only street trees as a suggestion of greenery along the route.

In rural areas much depends upon the character of the highway and its surroundings. Where it is on new location and the scenery is varied, practically no planting will be required in most cases.

Planting along modern high speed, high volume traffic arteries demands a design quite different from what has been accepted as "parkway planting." Basically it has been considered desirable for safety and ease of maintenance to define zones where no trees or shrubs should be preserved and no new plantings added. The restrictions quoted below designed for use in New York State have been applied to many miles of highway and parkway planting. While they may appear over-restrictive they have demonstrated that sufficient areas still remain on which to develop adequate landscape effects.

Traffic Speed

Highway designers select a curve radius according to desired speeds. Many drivers exceed not only the authorized speed on straight sections of highways but the designed speed on curves. To be on the safe side, removal of existing growth and addition of new plantings should relate to speeds as they may actually occur under traffic conditions.

Actual speeds and corresponding sight distances have been

formulated by using the standards for designing curves for given speeds and adding margins for overdrive and safety. Table 1 is based on "Traffic Engineering Handbook," a joint publication by the Institute of Traffic Engineers and the National Conservation Bureau, for curves "without superelevation." This table shows speeds about 20 percent higher than the referenced text to represent "overdrive." It also indicates speeds with relation to super-elevated curves.

Table 1

MAXIMUM PROBABLE SPEEDS FOR VARIOUS RADII

Radius in Feet	Without Super-Elevation MPH	With Super-Elevation MPH	Radius in Feet	Without Super-Elevation MPH	With Super-Elevation MPH
100	33	34	800	58	66
150	36	39	900	59	67
200	41	44	1,000	59	68
250	42	47	1,100	60	69
300	44	49	1,200	60	70
350	47	52	1,300	60	71
400	49	54	1,400	60	72
450	50	56	1,500	61	73
500	52	59	1,600	62	74
600	54	62	1,700	64	75
700	56	65			

Stopping Distances

If a disabled car or other obstruction occurs on a highway, an approaching driver should be able to see it far enough in advance to come to a full safe stop before colliding. No tree or shrub should obstruct his vision. In determining tree and shrub locations it is therefore necessary to know the sight distance requirements according to his stopping distance.

Table 2 shows the perception time and brake reaction time for certain initial speeds as based on "A Policy on Sight Distance for Highways" by the American Association of State Highway Officials and the "Traffic Engineering Handbook."

Thus at 25 MPH or 36.6 ft. per second (v) as an initial speed, there would be a combined perception time and brake reaction time of 3.12 seconds (t_1). This gives a perception and brake reaction distance (S_1) of 114 feet ($S_1 = vt_1$). Vehicles of course decelerate at different rates. A rate of deceleration based on

engine drag and wind resistance alone will be about 2 miles an hour per second. A deceleration of 12 miles an hour per second is about the extreme for car passenger comfort. Converting 12 miles an hour per second by the factor 2.151 gives 25.8 feet per second per second (d). The time required for braking distances of $t_2 = v/d$ or 1.4 seconds. Having the time (t_2) and the deceleration rate (d), the braking distance of $S_2 = \frac{d \text{ plus } 2}{2}$ or 25.3 feet.

Adding the braking distance of 25.3 to the perception and brake reaction distance of 114 feet gives 139.3 feet as the total distance required for a vehicle to stop from an initial speed of 25 MPH at a rate of deceleration of 12 miles an hour per second.

Table 2

STOPPING DISTANCES FROM VARIOUS VELOCITIES AND AT VARIOUS DECELERATION RATES

MPH	12 MPH/Sec	10 MPH/Sec	8 MPH/Sec	6 MPH/Sec	4 MPH/Sec	2 MPH/Sec
25	140′	145′	150′	165′	195′	270′
30	170′	175′	190′	210′	245′	360′
35	200′	210′	225′	250′	305′	455′
40	230′	240′	260′	290′	360′	560′
45	260′	280′	300′	340′	430′	685′
50	285′	310′	340′	395′	495′	815′
60	350′	380′	425′	495′	690′	1,100′
70	470′	455′	520′	620′	820′	1,440′

The application of these processes accounts for the difference of 5-foot stopping distance from 10 to 12 MPH per second deceleration. High speed roads are usually designed on the basis of a deceleration of four miles an hour per second. Rates of deceleration under usual highway conditions should probably be based on six or eight miles an hour per second.

Table No. 3 shows the effect of plus and minus grades on rates of deceleration.

Planting Zones

Reference to Table 1 gives the maximum speed to be expected at any curve. Table 2 gives the distance required for stopping from this speed according to a selected rate of deceleration. From the layout of this distance along the line of travel on a curve, a sight distance chord can be plotted. The plotting of a succession of such chords will define a zone where sight distance should be preserved

Table 3

EFFECT OF GRADE ON STOPPING DISTANCES

Assumed Design Speed	Upgrade Decrease in Stopping Distance			Down Grade Increase in Stopping Distance		
	3%	6%	9%	3%	6%	9%
30	− 0′	−10′	−10′	+ 0′	+10′	+ 10′
40	−10′	−10′	−20′	+10′	+10′	+ 20′
50	−10′	−20′	−30′	+10′	+30′	+ 40′
60	−20′	−30′	−50′	+20′	+40′	+ 70′
70	−30′	−50′	−70′	+30′	+70′	+120′

and beyond which any obstructions will be acceptable. Such a layout is shown on Figure No. 3.

If, due to the planting design or the existence of desirable trees, the limitation of planting zones by this method leave a hard, unin-

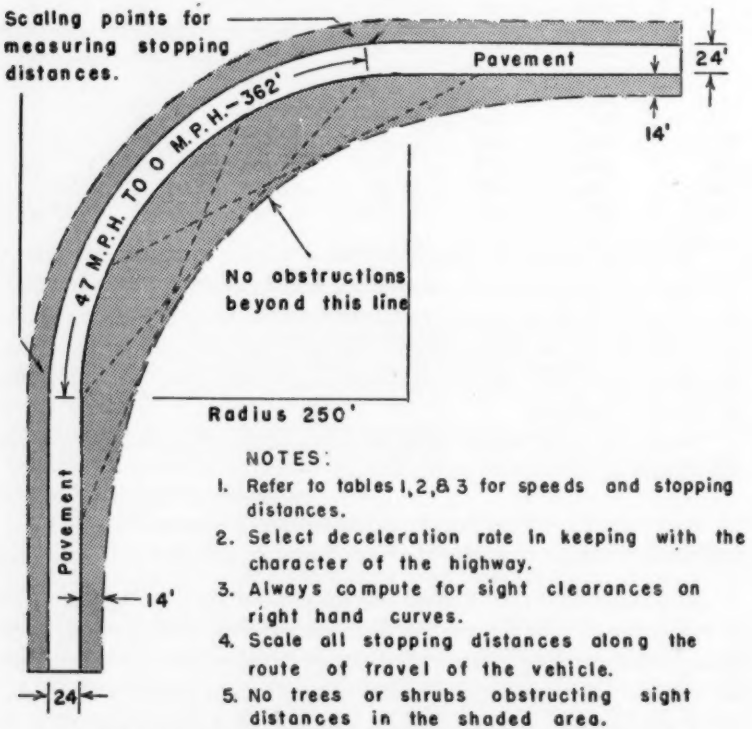

Scaling points for measuring stopping distances.
Pavement
24'
14'
47 M.P.H. TO 0 M.P.H.—362'
No obstructions beyond this line
Radius 250'
Pavement
14'
24'
NOTES:
1. Refer to tables 1,2,&3 for speeds and stopping distances.
2. Select deceleration rate in keeping with the character of the highway.
3. Always compute for sight clearances on right hand curves.
4. Scale all stopping distances along the route of travel of the vehicle.
5. No trees or shrubs obstructing sight distances in the shaded area.

FIGURE 3. Clearance of vegetation for sight distances on highway curves.

teresting outline, it may be possible to justify a few plants within the prohibited zone. They should only be high headed trees however and their small quantity and dispersed arrangement should cause no real restriction until their trunks are very large.

Where one highway crosses another on a separate level and no interchange of traffic is involved, no sight distances need be considered to govern the location of plantings.

At simple intersections as shown on Figures 4 and 5 the permitted speed on the highways should be determined. Increase these

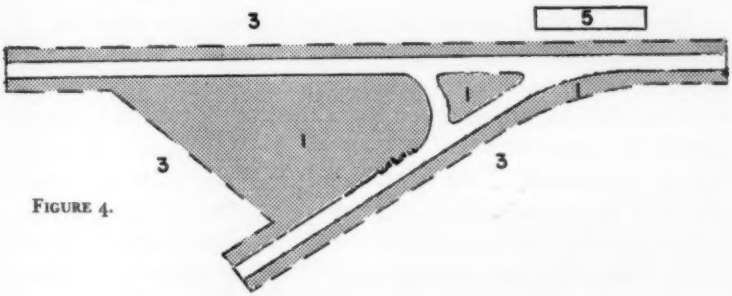


FIGURE 4.

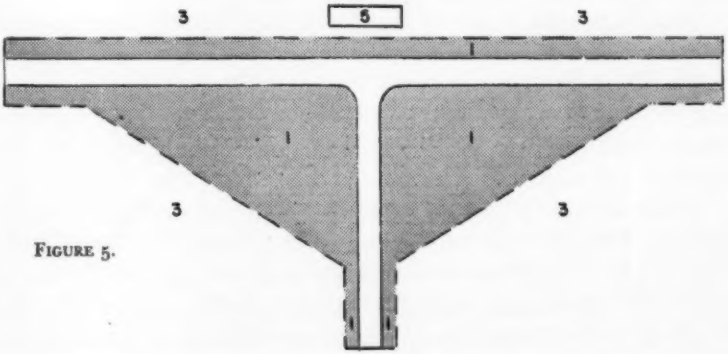


FIGURE 5.

DESCRIPTION OF ZONES

1. Grass or low ground cover only.
2. Intermittent planting only.
3. Tree and shrub planting permissible.
4. Tree and shrub planting desirable.
5. Shrub planting only permissible and desirable.

Clearance of vegetation for sight distances at highway intersections.

speeds by 20 percent for "overdrive." Consult Table 2 for the stopping distance from these speeds. The plotting of these distances and their sight distance chords will define the clear vision zones.

Sight distances are particularly critical at highway intersections having an interchange of traffic. Examples of planting zones based on sight distances are shown on Figures 6 and 7 for two intersection designs.

Headlight Glare

Headlight glare is often considered a reason for planting. It is generally accepted that for speeds of 45 miles per hour or faster, the upper beam of headlights should be used and it has also been determined that for a distance of about 800 feet within the concentration of the upper beams of sealed beam headlights the intensity of light is unbearable. Until head lights or windshields are built to overcome excessive brilliance it would appear highly desirable to design highways which avoid the possibility of headlight glare. This would mean wide and varying width medians or having opposing traffic lanes on different levels.

Plantings used to screen headlights have several objectionable features. Some observers believe that a screen is only needed at curves where lights sweep across the lane of travel. Others contend that such a glare is momentary and can be tolerated but a greater offense comes from the steady brilliance of oncoming lights where a highway is straight.

A continuous hedge would seem to be necessary to meet these objections. Evergreen plants, where growing conditions are suitable, or multiple rows of deciduous shrubs would be required to provide year round protection against headlights. Either type of planting would be very expensive to plant and to maintain. It would add to the cost of picking up papers and windblown litter. It would interrupt the mowing pattern and might interrupt the drainage pattern. In the north country it may contribute to snow drifting on the pavement and restrict the area for snow disposal or the storage of snow may break the plants down. They are a general nuisance from the maintenance standpoint and unless they occur on wide medians they are conspicuous, unnatural and no addition to the scenery.

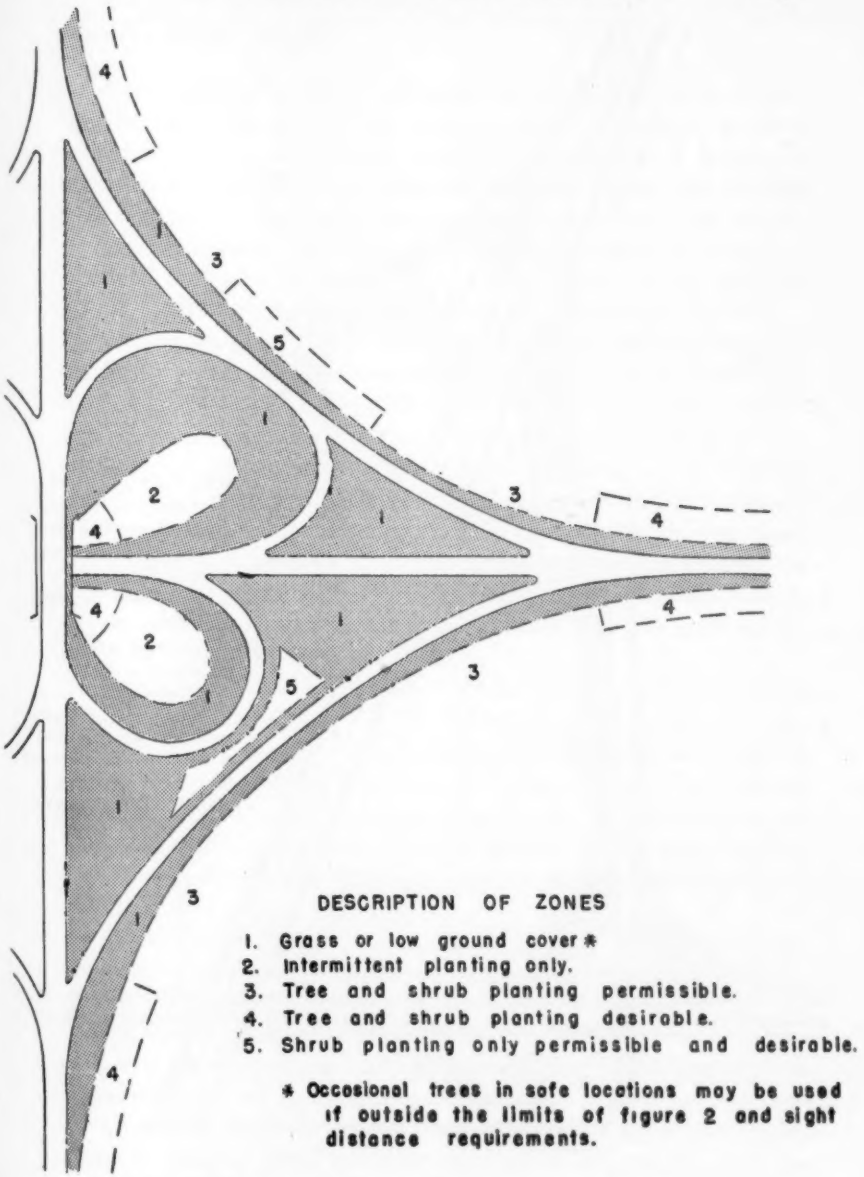


FIGURE 6. Clearance of vegetation for sight distances at highway intersections.

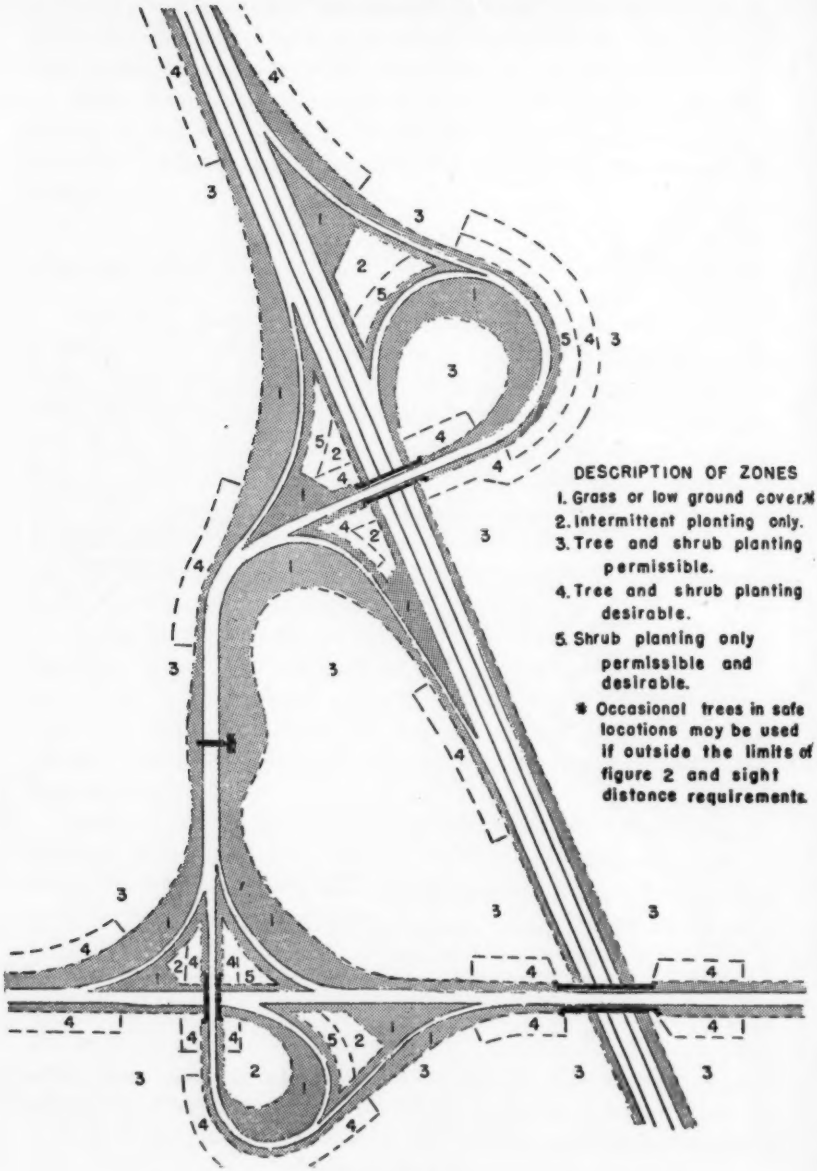

DESCRIPTION OF ZONES
1. Grass or low ground cover.*
2. Intermittent planting only.
3. Tree and shrub planting permissible.
4. Tree and shrub planting desirable.
5. Shrub planting only permissible and desirable.
* Occasional trees in safe locations may be used if outside the limits of figure 2 and sight distance requirements.

FIGURE 7.

Planting at Interchanges

A new value of planting is coming into recognition with the designs for interchanges on major highways. These layouts often cover fifty or more acres of land and considerable portions of them such as the interior of the large lobes are not usable but still require maintenance. If grass covered, they would add materially to the burden of mowing. The cheapest treatment is to leave or introduce the kind of vegetation indigenous to the region. In the northeast humid section of the country this would be a forest type of cover.

Drivers who are not familiar with the routes, or the pattern of the interchange, need to be carefully and sometimes repeatedly informed by large, clearly worded signs. The need of quick comprehension on which lane to turn into may be required in rapid succession in a large and complicated series of junctions. Speed of traffic is customary for those familiar with the layout of the interchange. This adds to the difficulty for a stranger and there are also times when fog or blowing snow adds to everyone's difficulty in keeping his bearings. Tall growing plants offer a considerable advantage by hiding the disconcerting movement of practically all of the traffic not in the same lane of travel.

Plant growth between the lanes of main travel and a lane leading to an interchange should help in distinguishing the two, either by day or night. Planting in the median may be an added advantage in defining the change in direction for a car entering the flow of through-traffic. It would also help in screening the headlights of an incoming car from sweeping across the main lanes and disconcerting the through-traveler. Several such areas for plant growth are shown in Figure 6.

Usually the bridge structures are an attractive part of the scenery and their appearance is enhanced by plant growth flanking them. The approach ramps, however, often silhouetted against the sky are conspicuously artificial land forms. It only takes the crowns of one or a few trees to screen and subordinate these hard lines in the scenery.

Unless the intersection has been built from carefully thought-through grading plans based on contours it is probable that the several roads in the unit have uniform and angular slopes on both

cuts and fills. The completed construction may have the regularity of railroad embankments referred to previously and because of the intersection pattern the slopes are seen from alongside at close range. A covering over with trees should benefit the whole by its screening effects.

Highways and Roadsides as an Entity

With modern highways being built with longer radius curves which approach if not actually attain the alignment of spiral curvature as the designs are adapted to the terrain, with greater vertical sight distances, and with broad stable shoulders and flattened slopes well protected by turf, the new roads and roadsides have an increasing similarity to parkway character. It takes a greater right-of-way width to accommodate these features but the advantages of safety, easier maintenance and benefits to the traveler in terms of pleasurable motoring will outweigh the increased costs. They reflect the advantage of a team of designers working together in the attainment of a highway which serves its intended purpose and being efficient is inherently safe and attractive.

North Dakota Highway Safety Study

NORMAN DAMON

Mr. Damon, vice president of the Automotive Safety Foundation, has been engaged in work connected with highway transportation and traffic safety for more than thirty years. He has been actively identified with the automotive industry's participation in all major activities concerned with the prevention of traffic accidents—from Committee Secretaryship in the First Annual Conference on Street and Highway Safety in 1924 to his present position with the Foundation. Among other activities, Mr. Damon served as director in the 1954 comprehensive study of state highway safety functions for the State of North Dakota. He is a member of the Executive Committee of the Traffic and Transportation Conference of the National Safety Council and a member of the National Committee for Motor Fleet Supervisor Training.

IN 1953, the state legislature of North Dakota, concerned over a rising toll in traffic-accidents, passed a resolution directing its legislative research committee to carry out a searching study of every official safety activity conducted by the state, and to report its recommendations to the 34th legislative assembly convening in January of 1955.

Back of this directive was a growing awareness on the part of public officials and citizens alike that what was being done was not enough—that it was time for more positive action in dealing with the accident problem. The organized public had expressed itself at annual state safety conferences and at the governor's highway safety conferences, urging strong remedial measures.

In ordering the highway safety study, North Dakota's lawmakers recognized that the first step to improve traffic safety performance should be taken by the legislature. The legislature has responsibility for enactment of sound and adequate laws, and for budgetary provision for the administration of those laws. The action was in recognition, too, of the fact that thorough study of any problem is preliminary to successful solution.

Such a study was made. It required a period of about a year to

complete. Into it went the thinking and technical experience of the nation's top authorities. All in all, it was probably the most comprehensive and exhaustive study ever undertaken by any state in the field of highway safety.

Thus, North Dakota was the first state to attack its highway safety problems by a legislative "across-the-board" approach based on fact-finding and analysis.

Factual Study Is Basis for Legislative Action

As a result of that study, the North Dakota legislature, at this writing, has before it a number of proposals from its legislative research committee for legislation, which, if translated into law, will lead the way to greater safety on the state's streets and highways.

Among the major bills submitted are those providing for more streamlined and better integrated administration of the state's major highway safety functions for greater efficiency and effectiveness, wide revision of the state's motor vehicle laws to bring them up-to-date and into closer conformance to the uniform vehicle code, and establishment of a modern accident-reporting system.

In carrying out the legislature's directive that a highway safety study be made, the legislative research committee, headed by Representative Ralph Beede, appointed a subcommittee on highway safety, consisting of Representative Roy A. Holand, as chairman; Senator Harvey B. Knudson and Representative Hjalmer C. Nygaard. The subcommittee was authorized to obtain the services of a qualified, disinterested organization to assist in conducting the study.

The subcommittee invited the Automotive Safety Foundation, a non-profit organization dedicated to safe and efficient highway transportation, to supervise the study work and to prepare a report on its findings and recommendations. As a result, the author of this article served as director of the highway safety study.

It is interesting to note that the highway safety study was preceded by two other significant studies authorized by the North Dakota legislature. In 1952 a state-wide engineering study of highway needs was made and in 1953 work was completed on a study aimed at modernizing the state's highway laws.

As indicated, the highway safety study covered every strategic phase of the subject, including:

Motor vehicle laws, accident records, driver licensing and controls, vehicle registration and certificate of title, enforcement of traffic laws by the highway patrol, enforcement by the courts, safety education in schools, the financial responsibility law, unsatisfied judgment fund, and traffic engineering.

Work Carefully Organized

The study was conducted under highest standards to assure the validity of its findings and maximum value as a legislative guide. A brief review of the study organization and methods may be of interest to other states.

So the study would reflect the best thinking, the director obtained highly qualified staff assistance from six national organizations, each specializing in particular professional fields. The organizations accepted responsibility for a preliminary task-force study of a specific function. Their people, along with Automotive Safety Foundation staff, gathered statistical data and other information, and arrived at needs in the various fields of state responsibility.

Members of the task force and the study phase for which each was responsible were:

David M. Baldwin, director, traffic division, National Safety Council—accident records; Glenn V. Carmichael, assistant director of training, Traffic Institute, Northwestern University, and Basil R. Creighton, assistant executive director, American Association of Motor Vehicle Administrators—driver licensing; Mr. Creighton—vehicle registration and certificate of title.

Theodore Loveless, assistant director of field service and Clifford Fernstrom, field representative, both of the International Association of Chiefs of Police—enforcement by the highway patrol; James P. Economos, director, traffic court program, American Bar Association—enforcement by the courts; Stanley A. Abercrombie, assistant secretary, National Commission on Safety Education, National Education Association—school safety education.

Kenneth F. Neu, American Association of Motor Vehicle Administrators—financial responsibility law and unsatisfied judgment

fund; D. Grant Mickle, director, traffic engineering division, Automotive Safety Foundation—traffic engineering aspects of the highway safety problem, and Anthony Antony and John A. Vance, both of the Foundation's Laws Division—legal phases.

In addition, the study director was fortunate in having as consultants, Sidney J. Williams, assistant to the president, National Safety Council, and Louis R. Morony, director of the Foundation's Laws Division. Their counsel throughout the study proved of tremendous value. Automotive Safety Foundation associates, Reynolds Weaver and John H. Magill, gave counsel and assistance. The Bureau of Public Roads, United States Department of Commerce, cooperated in the study, and aided in financing certain parts of it.

Performance Measured Against Standards

The task forces spent all necessary time on the scene in North Dakota for thorough study of their respective subjects. Whole-hearted cooperation and assistance came from the state's department heads and their staffs.

Current performance in North Dakota was measured against nationally accepted standards, and administrative structures were carefully examined in the light of conditions and situations peculiar to the state. Each cooperating specialist reported his conclusions and recommendations to the study director.

The task-force reports were evaluated and consolidated under supervision of the study director. The final printed report was published in September 1954, under the title, "Safer Highway Travel for North Dakota." This document outlined to the legislature the combined findings of the study group, and suggested how deficiencies could be overcome in each of the areas covered by the study.

The study also produced a number of administrative recommendations which were formally transmitted to the heads of the state's departments and agencies concerned. It is interesting to note, in this connection, that during the course of the study the state's administrators took many immediate steps to overcome deficiencies revealed as the study progressed. As a result, a number of the study's important administrative recommendations were activated even before the final report became generally available.

The legislative research committee submitted its report on the highway safety study to the 34th legislative assembly. The committee adopted the majority of the study recommendations as its own, drafting proposed legislation to implement them. The committee saw fit to modify some of the study recommendations to meet conditions and developments subsequent to the study. These differences will be pointed out in discussion to follow. Also, the committee felt that action should be deferred on a few of the study recommendations.

Study Serves As Blueprint

In presenting the study report and recommendations to the legislature, the legislative research committee stated:

"Those who prepared it offered it as a blueprint for present as well as future planning and action. We recognize that it may take considerable time to place all of the recommendations in operation. . . We are recommending as much of it as we feel is legislatively feasible at the 1955 session of the legislature. As various parts of the program are adopted and successfully placed into operation they can be supplemented by having further portions of the program enacted in subsequent sessions of the legislature. Perhaps the members of the legislature and others may consider the recommendations of the committee to be overly conservative. We feel that it would be best to enact a substantial portion of the proposed program and place it in operation, rather than to attempt a full scale enactment, perhaps before the public and legislature are ready for such a program."

In his message to the legislature, Governor Norman Brunsdale supported the proposed legislative program for highway safety by saying:

". . . legislation based upon recommendations offered by the Automotive Safety Foundation will be submitted through a committee to this session of the legislature. I hope you will give serious consideration and pass such legislation as seems necessary and beneficial."

The final report of the highway safety study was not only strongly endorsed by the legislative research committe and its subcommittee on highway safety, but also by the citizen and highway-user organizations whose representatives attended a public hearing on the subject at the state capitol in Bismark.

Such official and public acceptance of the report was based on

lively awareness of the needs of the state, on sincere desire to bring about improvements, and on the knowledge that those who conducted various phases of the study had the professional integrity and experience to arrive at sound and workable recommendations wholly in the public interest.

Some of the highlights of the highway safety report to the legislative research committee are of general interest, along with brief explanations of the what and why of the study's major recommendations.

Most Legal Authority Already Exists

The study revealed, that most of the legal authority for highway safety functions of North Dakota already existed. But this legal authority, in general, was found out-of-date in relation to conformance with the Uniform Vehicle Code, the nationally recommended standard. Then, too, state functions in highway safety had been scattered through two or more departments, and in some cases misplaced.

This is not an unusual situation. By and large, state laws relating to highways and to motor vehicle use in the United States have been put together piecemeal over the years to meet the ever growing problems accompanying the growth in motor vehicle registration. Placement of function frequently has been on the basis of expediency. The result is often a hodge-podge of legal tools, deplorably inadequate for the big and complex task for which they were intended. Often the state legislatures themselves are unaware of the status of their laws.

Only when a state determines, as North Dakota did, to study its laws and functions, is the true situation revealed.

The same condition exists in many cities. Several years ago, for example, the City of Detroit undertook a broad management study of its street traffic problems. The study found that Detroit had, over the years, so diffused legal authority and responsibility for management of street traffic affairs that effective coordination of activities was virtually impossible. Instead of being centralized in one department where specialized skills could be brought to bear, traffic functions were scattered among some fifteen different agencies of the

municipal government, in addition to the mayor and common council.

The true condition of Detroit's legal framework was not apparent to the law-makers until the study revealed it. They have since acted to bring their laws up-to-date for more efficient traffic management.

The situation in North Dakota, then, was not uncommon. There, as in other states, the administrators charged with responsibility of carrying out the intent of the law have simply done the best they could with the legal tools they had at hand.

Once a jurisdiction has taken the important step of getting and evaluating the facts, the logical next move is to take whatever action is necessary to gear its legal and administrative machinery to the desired end. In North Dakota, the study revealed that certain changes in the laws, plus realignment of some of the management functions related to highway safety, would accomplish the report recommendations.

Centralized Administration Urged

Divided authority and responsibility for highway safety, making coordination difficult, was found to be a serious drawback in North Dakota. Administration through a central agency was believed to be more efficient, economical and effective, under the thesis that as many highway safety functions as is practicable should be concentrated in the state agency that has safety as its primary purpose.

A public safety division already existed in the state highway department, although its duties were confined largely to safety education. The study report recommended that the public safety division be lifted out of the highway department and be given statutory authority as a full department of the state government.

Effective administration of highway safety functions demands that the responsible agency be given all the authority it needs to do its job, if necessary through elevation to full departmental status.

The intent of the study recommendation was that the proposed new department of public safety take over from the highway department the functions of public safety education, driver licensing,

suspension and revocation of driver licenses, driver records, and administration of the financial responsibility law and unsatisfied judgment fund. It would also assume the functions of driver license examination and renewal of driver licenses, now handled by the state highway patrol. In addition, the study recommended that the new department establish a program of driver improvement and operate a central accident records bureau.

The primary function of the North Dakota Highway Department is, of course, to construct and maintain the state's highway plant, and to control traffic operations.

The North Dakota Highway Patrol was created to enforce the state's traffic laws, rules and regulations.

Relieving these two departments of extraneous duties, as the study recommended, will permit them to concentrate their resources on principal functions assigned to them by law.

Although, in reporting to the legislature, the legislative research committee has moved toward the centralization of highway safety functions, creation of a new separate department of public safety was not included in its recommendations.

Under the proposal advanced by the committee, the division of public safety in the highway department would be the central agency to administer many of the state's highway safety functions. The highway patrol would retain, at least for the present, its driver examination activities.

Uniform Rules of the Road

The study report points out that the legislature has the initial responsibility for enacting uniform rules of the road governing street and highway use. Uniformity of traffic laws and ordinances over the United States is highly desirable in the interests of safety. Driver confusion over rules and regulations which differ from state to state and from city to city contributes to accidents.

In North Dakota, as in many other states, traffic law had not kept pace with progress in the uniform law. The basic authority was there, but the law was badly out of date. In order that North Dakota vehicle laws might become uniform with those of other states, the study report recommended that the rules of the road sections of the

PROPOSED REALIGNMENT OF HIGHWAY SAFETY ADMINISTRATIVE FUNCTIONS IN NORTH DAKOTA

HIGHWAY PATROL
Enforcement of State traffic laws and regulations
Accident investigation
Use of accident-record information for selective enforcement
Forwarding accident-investigation reports to Central Accident Records Bureau in Department of Public Safety
Other activities specified by Legislature
REGISTRAR OF MOTOR VEHICLES
Motor Vehicle registration
Certificate of title
Motor vehicle equipment standards approval
*DEPARTMENT OF PUBLIC SAFETY (1)
A. *Public Safety Education
B. Driver Licensing
#Driver license examination
*Issuance of original license
#Renewal of drivers license
*Suspension and revocation of driver license
*Central driver records file
Driver improvement
C. Accident Records
Central Accident Records Bureau
D. Official Employee Safety Program
E. Insurance
*Financial Responsibility
*Unsatisfied Judgment Fund
F. Services of executive secretary for Official Coord. Committee
HIGHWAY DEPARTMENT
Planning, design, construction and maintenance of highways for safety
Traffic engineering to assure safety of motor vehicle use

(1) Establish by statute

* Transfer from Highway Department

Transfer from Highway Patrol

Prepared by: Norman Damon
Vice President
Automotive Safety Foundation
Director of Study

uniform vehicle code, the nationally accepted standard, be substituted for the state's existing statutes. This action was recommended as more efficient than the difficult process of amending and supplementing existing law to bring it into conformity with the Uniform Code.

The legislative research committee adopted the recommendation, with minor changes to be written into the law to fit conditions peculiar to North Dakota's predominently rural character.

Further, the committee approved the study report's recommendation that North Dakota cities be enabled by law to adopt by reference a model traffic ordinance, to encourage uniformity in all municipal statutes. Although the North Dakota law grants general authority for such adoption, the committee deemed it advisable that the law be amended to make it more specific.

The study report suggested that the cities and towns of North Dakota develop cooperatively their own model ordinance based on the nationally recognized model traffic ordinance.

Colorado, several years ago, was the first state to enact such adoption-by-reference legislation. The Colorado Municipal League had developed a model ordinance which received official state approval. Today, more than fifty Colorado cities and towns have adopted the model ordinance by reference.

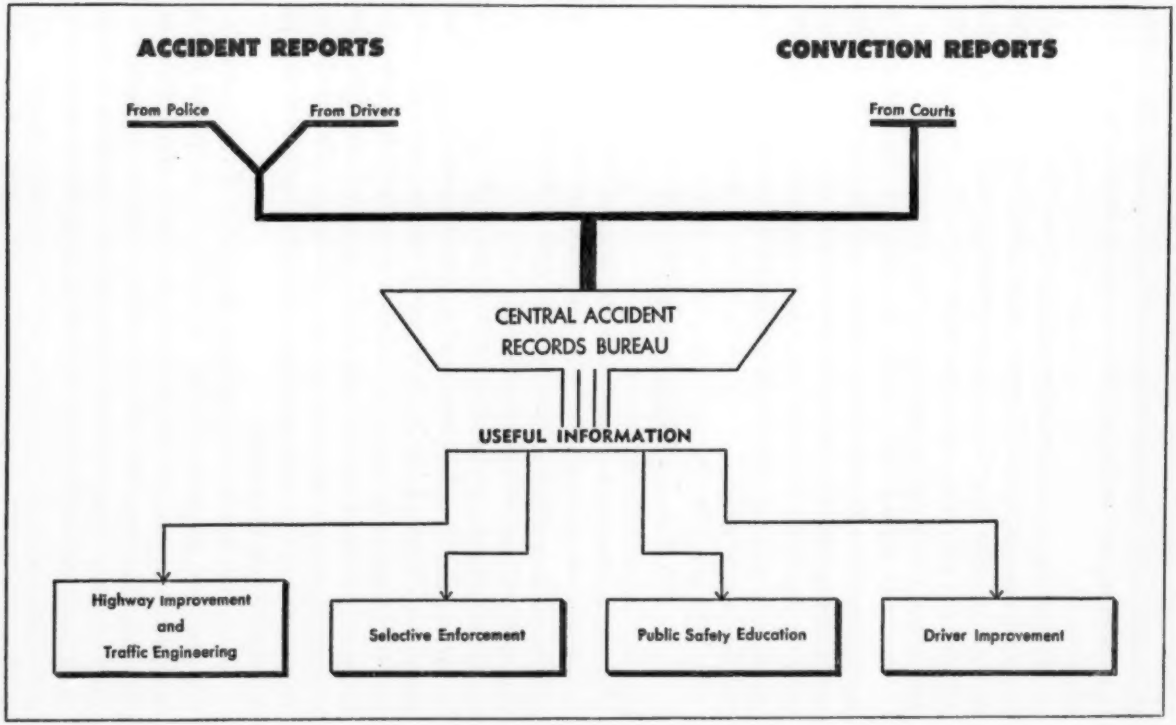
The advantage lies in the ability of cities to adopt uniform legislation for safer use of streets without the expense of lengthy verbatim legal advertising in the public press.

Accident Records

Special emphasis was given in the study report to the need for an adequate system of accident records. Such records, and their intelligent use, are basic to a successful highway safety program. Without such information, departments and agencies of state government dealing with various phases of the highway safety program must work practically in the dark on preventive measures. They must have before them the what, where, when and why of traffic accidents so that their activities may keep abreast of needs.

There has been no provision in North Dakota law requiring that drivers and investigating police officers file accident reports with any

CENTRAL ACCIDENT RECORDS BUREAU NOW IN THE DIVISION OF PUBLIC SAFETY



central state agency. There was only a limited reporting requirement under the Financial Responsibility Law, and a law requiring drivers to report accidents locally to city police or county sheriff's department.

The report recommended repeal of sections of the state's existing law, with substitution of Chapter 10 of the Uniform Vehicle Code in order to provide that all accidents involving death, injury or property damage exceeding a stated amount must be reported by drivers and investigating police officers to a state agency.

Accident information would be analyzed, interpreted, summarized and made available in useful form to other state departments and agencies as a guide to remedial action.

The legislative research committee concurred in this recommendation, placing the central accident records bureau in the division of public safety.

Enforcement by the Patrol

One of the most immediately effective ways of reducing accidents is to step up enforcement activity. That assumes that a state's police enforcement agency is up to proper strength and well equipped, and that traffic court procedures are sound.

North Dakota law has limited the state highway patrol to forty officers. Such a force has proved inadequate to a sound enforcement program. Therefore, the study report recommended that the manpower limitation be repealed, and that the size of the patrol be determined by the governor and the superintendent of the patrol, subject to budget approval of the legislature. The study report recommended that forty-six officers be added to the existing patrol within the next biennium.

Size alone had severely limited the ability of the patrol to give adequate enforcement coverage. In addition, the patrol had accumulated some twenty-five special duties which, along with normal sickness and other time off, had reduced the average daily traffic patrol force on duty to about eighteen men. Obviously, additional manpower was imperatively needed if the patrol were to carry out all its functions.

In adopting the study report's recommendation, the legislative

research committee, for fiscal reasons, urged a more gradual approach to increasing the patrol's authorized strength. The committee has asked the legislature to add twelve men the first year, and six the second year of the biennium.

Also in accord with a study recommendation, the committee asked for legislation to authorize the admissibility in court of speed violation evidence obtained by radar.

Enforcement by the Courts

In the area of traffic court administration, the study report urged use of the uniform traffic ticket, and the reporting by the courts of driver convictions and all failures to satisfy judgments under the financial responsibility law and unsatisfied judgment fund to the recommended department of public safety.

The uniform traffic ticket assures greater certainty of punishment for violations by practically eliminating the ticket "fix."

Court reporting of convictions is important to maintenance of complete driver records and to the driver control and improvement programs.

The task-force report on the traffic courts study involved so much reorganization of the judicial structure that it has been printed separately by the North Dakota Bar Association, preliminary to the bar's review and recommendation to the legislature.

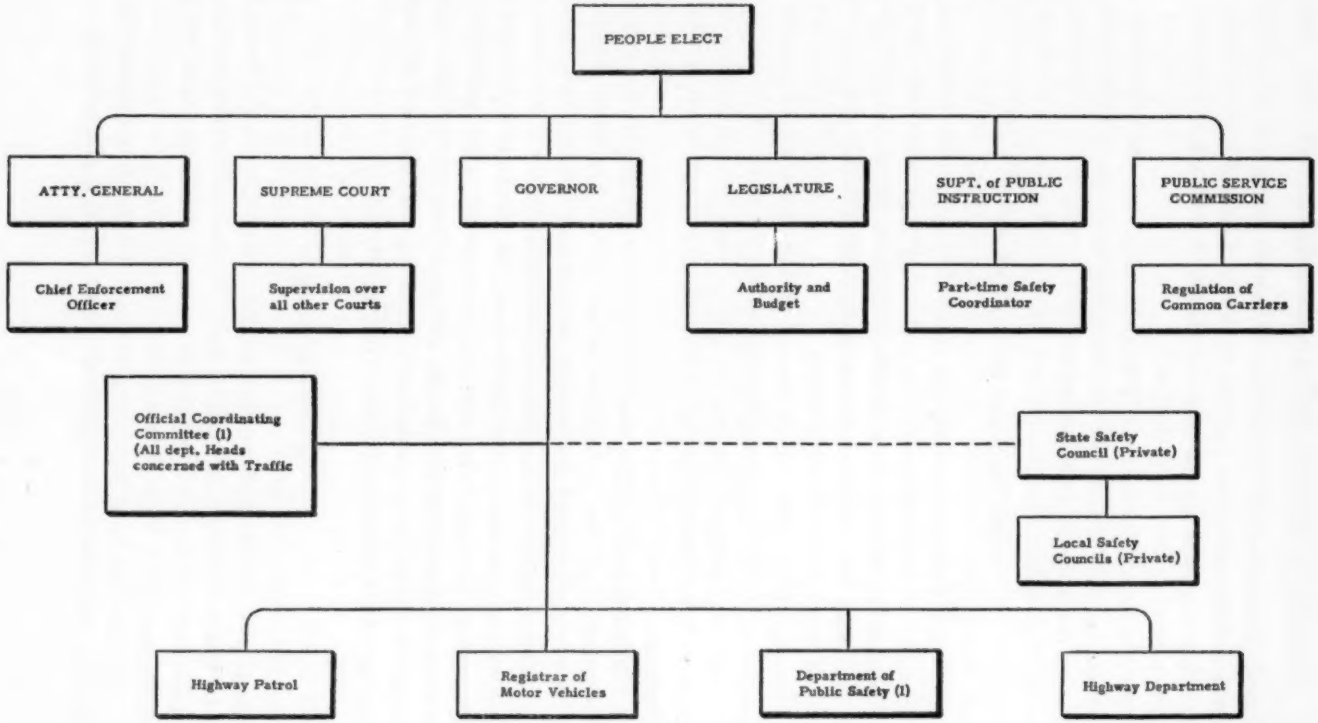
The court recommendations contained in the study report were approved by the legislative research committee, which asked that the state supreme court require use of the uniform traffic ticket, and that all courts be required by law to report driver convictions and judgment failure to the division of public safety.

Driver Licensing

Historically, the original purpose of driver licensing in the United States was to identify drivers. Only later, did driver licensing become a source of revenue. Initially, there was no driver test, nor legal restrictions on use of the license.

The time has come for all states to establish the driver license law for what it should be—a legal instrument granting the privilege of

PROPOSED STATUTORY ORGANIZATION FOR HIGHWAY SAFETY IN NORTH DAKOTA



(1) Establish by statute

Prepared by Norman Damon
Vice president
Automotive Safety Foundation
Director of Study

using the highway to those who can qualify and who merit continuation of the privilege by demonstration of proper driving habits. Controls must be established in the public interest over those who cannot or will not conform to good driving practices.

These basic requirements are provided in the driver licensing provisions of the uniform vehicle code. In light of the burden of revising existing legal provisions in the state, the report recommended that North Dakota substitute the provisions of the uniform vehicle code for the driver license sections of its own motor vehicle code.

This recommendation was accepted by the legislative research committee, with the exception that the Uniform Code provision for special licensing of chauffers was considered unnecessary since such licensing is "quite well controlled by both the municipality and the organizations for which they work." The driver licensing function would be assigned to the division of public safety.

Registration and Certificate of Title Law

The task-force study found that motor vehicle administration was quite satisfactory under North Dakota's registration and certificate of title laws. Only two recommendations were made, the first calling for simple substitution of words in one section of the law, and the second granting broader authority to the registrar of motor vehicles in giving approval, where warranted, to new developments in vehicle lighting, braking systems and other equipment.

Both these proposals were approved and included in the legislative research committee's recommendations to the legislature.

Financial Responsibility and Unsatisfied Judgment

Administration of the financial responsibility law and the unsatisfied judgment fund was found to be adequate. No change was recommended in the former, until and unless need is indicated by future accident records. It was recommended, however, that both be administered by the proposed new Department of Public Safety. The earlier engineering study of highway needs had recommended that these functions be transferred from the highway department.

The study report recommended, also, that uninsured drivers be assessed under the unsatisfied judgment fund at least three times the amount paid by insured drivers. This would place a fairer share of the burden on those who are not providing financial protection for their fellow motorists. North Dakota law calls for special assessment against motorists to rebuild the fund only when it drops below $100,000.

The fund is strictly an economic measure, providing a means of last resort after all other efforts to collect court judgments in accident cases have failed. Nevertheless, it furnishes a measure of protection worthy of legal study and legal safeguards against abuse.

The only action asked by the legislative research committee was transfer of both these functions to the Division of Public Safety.

Safety Education in Schools

One of the greatest needs in the field of safety education is a step-up in the high school driver education program. This was one of the principal findings in the North Dakota highway safety study.

Comparative studies have shown that young drivers receiving the complete driver education course, including both classroom and practice driving instruction, have only half as many accidents as those without such training. This becomes important when you consider the fact that every year more than two million boys and girls reach driving age.

The study revealed that only about forty-five of North Dakota's 360 four-year high schools offered the complete instructional course, although the state requires that each student successfully pass a driver education course as prerequisite to graduation from high school.

Many school districts in North Dakota are so small that they are unable to support a full program of training. To meet the need, the study recommended that the legislature permit two or more school districts to enter into contractual agreements so that full driver education courses may be established through joint use of an instructor and dual-control training car. It was recommended further that state-aid be increased to schools offering the full driver education course.

There is no state-wide plan to assure the safe and efficient operation of school transportation in North Dakota. Because many areas of the state are sparsely settled, scheduled school bus routes often are not feasible. An estimated three-fourths of the pupils riding to and from schools are being transported by family or family-furnished conveyances at school district expense.

The study recommended that the state take one or more reasonable steps to enhance the safety of pupils carried in privately owned vehicles.

In the area of safety education and pupil transportation, proposed bills already drafted by the legislative research committee would:

1. Allow contractual arrangements between school districts to permit joint operation of a driver education program.
2. Amend the present equalization fund aid program to increase state aid to schools offering complete driver education courses.
3. Require insurance on private vehicles used to transport school children at public expense; require that such vehicles meet certain standards and equipment specifications, and require special examination and license for operators of such vehicles, and certification by the school board clerk.

Coordination of Official Activities

Any state's highway safety program must be properly coordinated for best results. That means that the agencies involved must work together. Every responsible department must know what the other is doing, and gear its activities to fit.

Therefore, the study recommended that a coordinating committee of North Dakota officials, including the heads of all departments concerned, be established by statute. This committee of officials, through their several departments, would be available to provide technical assistance to communities and establish cooperative policy on traffic accident prevention with municipal officials and local public support organizations. Such a coordinating committee would relieve no state department of its legal responsibilities and prerogatives, but would lend to each the united strength of all.

One of the final recommendations of the legislative research committee was that a safety coordinating committee be provided by law as outlined in the study report.

For Future Continuing Action

In addition to the recommendations requiring immediate attention, the study report outlined to the North Dakota legislature several other steps believed to be worthy of consideration if the state's highway safety program is to reach maximum effectiveness:

1. Keeping the motor vehicle laws of North Dakota up-to-date at all times through periodic comparative review with the uniform vehicle code, especially just prior to each legislative session.

2. Continued state and city participation in the annual inventory of traffic safety activities, and best possible use of information obtained in the analyses of state and city reports to the inventory. Such information is vital as a guide to state and local governmental agencies, and to state and local safety councils, in planning their continuing programs of improvement.

Strong Organized Public Support Needed

Although not directly connected with legislative recommendations, no study of the highway safety problem would be complete without considering the need for well organized public support for official improvement programs.

The study report included a section devoted to this highly important subject, since the success of any program adopted by the North Dakota legislature will depend in large measure on public understanding and the amount of public support accorded to it.

Quoting from one paragraph of the study report, which sums up the public support job:

"The function of organized public support is to see that the public is informed, to mobilize support for the needed laws and administrative programs suggested in this report, to interpret to the people what the officials are doing, and to provide the officials with a 'sounding board' by which they can find out, in advance, the probable public reaction to any traffic program."

This requires close, continuous contact and cooperation between the legislature and other officials, and the citizens who use the highways, pay taxes and vote.

It further requires the existence of a strong state safety council,

including among its leaders all groups represented at the White House Conference on Highway Safety—agriculture, business, labor, public information media; civic, fraternal and other organizations, public officials, and organized women.

A similar safety council should be created in each sizable community, reaching out into the surrounding county, with county safety councils serving the purely rural areas. Coordination and follow-through to keep local safety organizations active and well-informed must be provided by the state safety council or through the proper governmental agency. Adequate personnel and facilities must be made available for this work.

Any State Can Benefit From Safety Study

The North Dakota highway safety study is a blueprint for the people of that state alone. Except in principle, the recommendations of the study report are not applicable to any other state, and they are not so intended.

But any state can benefit from a thorough study of its highway safety problems, particularly in relation to its motor vehicle laws and their administration. The North Dakota study provides a pattern for this.

Every area covered in the study is a vital part of the state's highway safety program. Every recommendation is important to improved performance in a well-rounded attack on the traffic accident problem.

Refinements can be made in the techniques and methodology of this pioneering North Dakota study. Those who participated in it believe that the study was not only well worth the time and effort spent on it, but will prove to be a highly useful tool to the people and officials of North Dakota in leading the way to safer use of motor vehicles on the roads and streets of that state.

Arizona's Dashed Shoulder Stripe

WILLIAM E. WILLEY

Mr. Willey has been the engineer in charge of the Economics and Statistics Division of the Arizona State Highway Department since 1946. Previously, he served for six years on active duty during World War II and for eight years was a bridge designer for the Arizona department. In 1953 he won fourth place out of 44,000 entrants in the General Motors Better Highways Essay contest. He holds a graduate professional degree in Civil Engineering from the University of Illinois. Mr. Willey is a member of the American Society of Civil Engineers and is registered in the State of Arizona as a Civil Engineer. For the last two years Mr. Willey has served as secretary-treasurer of the Western Association of State Highway Officials. He is currently technical advisor to the Special Legislative Highway Study Committee of the Arizona legislature.

TRAFFIC safety is everybody's business. When constructive comments are received from the public, highway officials should should sit up and take notice. Our experiment in shoulder stripes began on a winter night in 1953 when at a public traffic safety meeting of the Phoenix Community Council, a gentleman in the audience said he believed that many people ran off the shoulder because they didn't know where the shoulder was.

He suggested that perhaps a white stripe adjacent to the shoulder on an asphalt highway would identify the danger area and promote traffic safety. These shoulders nearly always have a rough and very uneven edge. As a member of the panel of so-called experts that night, I made a note of the suggestion and discussed it with the proper officials the following week. It was decided that we did have a problem and ways to improve the situation were discussed.

The national standard for a two-lane primary highway calls for two twelve-foot traffic lanes with two ten-foot shoulders for a total roadway width of forty-four feet. In Arizona, as well as in several other western states because of the rugged mountains and as an economy measure, the width of the shoulder has been reduced to eight feet, making a roadway forty feet across. For a number of years it has been the practice in Arizona to place a uniform subgrade and finished grade together with an asphalt pavement the entire width

of the roadway. This practice resulted from the decision to build maintenance in the original highway, by eliminating the rough edge at the standard twelve-foot lane width and doing away with grading operations on the normally unpaved gravel shoulder. It also acts as a roof over the entire section and keeps moisture out of the subgrade. No distinction is made in color or texture between the two travel ways and the shoulders.

For all practical appearances the road is a two-lane highway with twenty-foot lanes instead of the normal twelve. The material engineers believe this is good because wear on the roadway is distributed over a wider area and tends to eliminate ruts and preserve the pavement by keeping it alive. Motorists seem to have a different idea, since they use the forty-foot roadway as a three-lane or even four-lane highway. Beginning in 1946 some of our newest forty-foot highways with modern sight distance and with good alignment were the scene of some of the worst accidents in the state's history. The accident record in Arizona has never been very good. In recent years we have tied for the dubious honor of having the highest fatality rate or being in the worst two to four from the bottom. Last year with 394 killed the fatality rate was 9.76 per hundred million vehicle miles. The national average for 1953 was 7.1.

For the last two years most of the accidents have been of two general types. In the first case a car was driven off the shoulder and someone was killed in a single car accident. The other type involved the crossing of the centerline causing a head-on crash which, more often than not, results in five or six fatalities. It could be that the first driver left the roadway because he didn't see the shoulder? Perhaps the second driver crossed the centerline since he was driving too close to the middle of the road because he was afraid of the unseen shoulder? We decided it would be worth a try to place some experimental shoulder stripes on our standard two-lane, forty-foot roadway.

Experimenting with Shoulder Stripe

Two widely separated sections of roadway were chosen, where the traffic volumes and character of traffic would be different, and where an adjacent section of equal quality could serve as a check on the effectiveness of the shoulder stripe. It was decided to start with a

shoulder stripe one foot from the edge and that one-half as much paint would be used on each shoulder as was placed in the center stripe. The Arizona standard centerline marking is a white dash fifteen-feet long separated by twenty-five-foot blanks. The stripe has a width of four inches. The first section tested was a fifteen-mile section of U.S. 89 just north of the Arizona-Mexico border town of Nogales. The second highway to receive the white shoulder stripe treatment was a twenty-five-mile section on U.S. 66 just west of Kingman, Arizona.

It was hoped that the shoulder stripe would affect the lateral placement of motor vehicles in two ways:—

1) That it would spread traffic over twenty feet instead of twelve feet. In the case of a pending or near-accident this would provide more room in which to maneuver. It would also definitely establish the edge of the pavement and should assist in reducing single car accidents.

2) That with the shoulder definitely identified the motorist would have a tendency to move to the right, away from the centerline and thereby aid in the reduction of head-on collisions.

Along with these two test sections it was decided to place a shoulder stripe at all bridge and culvert structures. If the bridge stripe were made solid it would appear more as a barrier and would funnel traffic into and over the structure. The stripe was placed across the bridge deck and extended on an angle for 300 feet on each approach side of the bridge. This practice was even carried to the new roadway section forty feet wide where the structures were the full width of the roadway. It was deemed necessary to do this because of experience on a new road north of Tucson, Arizona, State Route 84, where all four corners of the bridge guardrail have been hit. In other words, a driver is no longer content to knock the guard rail off on his own side of the roadway but now crosses the centerline and knocks it off on the opposite side.

Record Favors Striping 5–to–1

We believe the bridge striping is logical and that it must be a good thing. However, we do not have any facts as yet to prove this point. On the other hand, there are definite indications that the shoulder

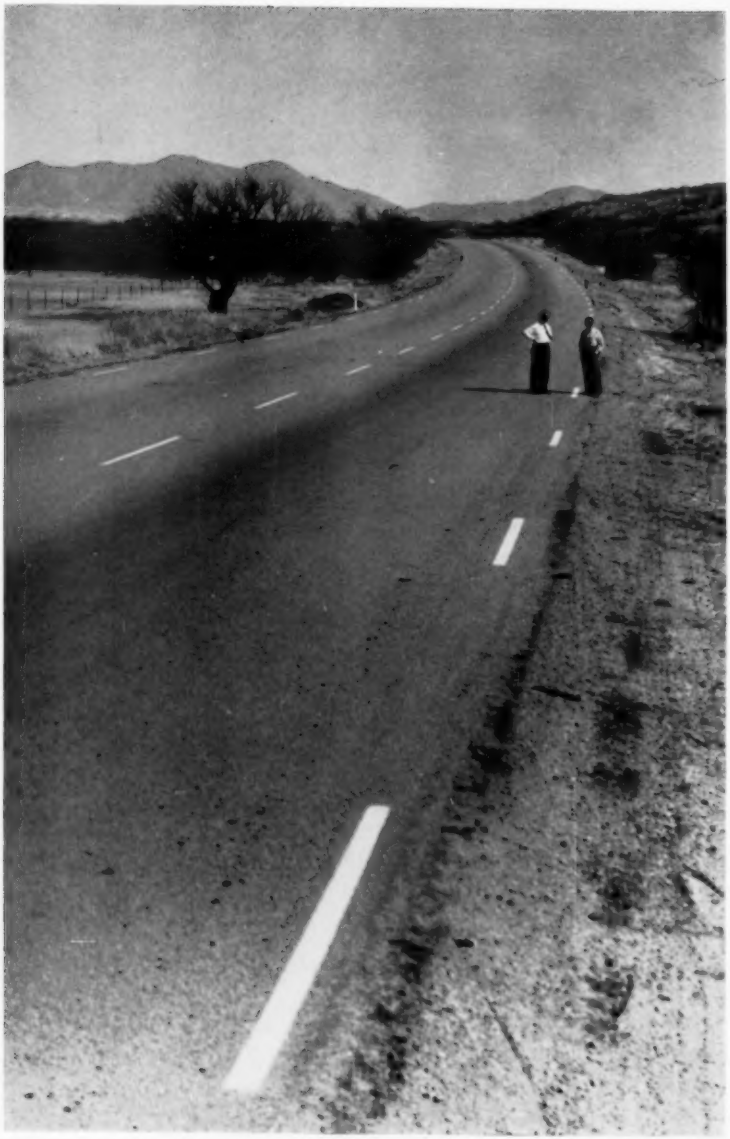


FIGURE 1. First stripe test was a 15-mile section of U. S. 89 north of Nogales.

FIGURE 2. Bridge stripe extends for 300 feet on each approach of the bridge.

stripe has been very effective north of Nogales, and the original fifteen-mile section has now been extended to a total of thirty miles. The accident record on two identical sections—where the same traffic passes over both sections but one has the shoulder stripe and the other does not—for the period of March, April, May, 1954 is as follows:—

Date	*Type Accident*	*Milepost No.*			
3–20	Non-collision	16.9	Drink—asleep	1 injured	5:20 A.M.
3–21	Non-collision	27.6	Drink—asleep	P. D. only	9:00 P.M.
3–25	Non-collision	27.0	Drink—asleep	1 injured	5:45 A.M.
3–28	Non-collision	7.7	Drink—asleep	1 injured	4:15 P.M.
4–3	Non-collision	20.6	Drink—speed—sleep	1 injured	10:45 P.M.
4–7	Non-collision	21.0	Speed—drink	1 injured	9:30 P.M.
4–9	Non-collision	22.6	Asleep	P. D. only	6:30 A.M.
4–11	Non-collision	30.1	Fatigued	3 injured	9:20 P.M.
4–14	Non-collision	27.4	Fatigued	1 injured	11:05 A.M.
4–24	Non-collision	28.0	Asleep	1 injured	not known
5–2	2 vehicles	13.1	Asleep—drink—wrong side road	3 injured	1:00 A.M.
5–5	Animal	4.7	No violation—horse in roadway	P. D. only	8:30 P.M.
5–15	Non-collision	4.6	Speed—asleep—ran off roadway	P. D. only	5:00 A.M.
5–16	Non-collision	17.4	Speed—poor lights—ran off roadway	3 injured	4:30 A.M.
5–22	2 vehicles	22.1	Follow too close—improper turn	P. D. only	10:35 A.M.
5–22	Non-collision	18.6	Asleep—speed	8 injured	4:30 A.M.
			FATALS		
4–17	Non-collision	24.18	Speed—asleep—ran off roadway	1 killed	3:05 A.M.
5–22	2 vehicles	25.00	Speed—improper passing rear end	1 killed	not known

(Road was striped—March 19, 1954)

The above table discloses a total of eighteen reported accidents up to milepost 30, although only four occurred within the first fifteen miles where the shoulder stripes were in place. One of these four involved a horse on the roadway and had no direct bearing on roadway striping. Both of the above fatalities occurred on the section without a shoulder stripe; there were no fatalities on the section with dashed shoulder stripes. All in all, the above record, while somewhat inconclusive, appears very good; approximately five-to-one in favor of the shoulder striped section. Records are now being kept and analysis has begun for comparing the thirty-mile shoulder striped section with a like section to the north that does not

have the complete striping treatment. Traffic on the roadway section under study, during the period, amounted to 1339 vehicles per day of which 231 were trucks.

Additional data comparing the first fifteen-mile test section with the second unstriped fifteen-mile section for the period March to October, 1954 are as follows:—

Date	*Type Accident*	*Milepost No.*			
5–22	2 vehicles	22.1	Improper turn—follow too close	P. D. only	10:35 A.M.
5–16	Non-collision	17.4	Speed—lights	3 injured	9:30 P.M.
5–22	Non-collision	18.6	Asleep—speed	8 injured	4:30 A.M.
6–2	2 vehicles	5.0	Drink—wrong side road	P. D. only	5:30 P.M.
6–4	2 vehicles	2.0	Drink—wrong side road	1 injured	7:55 P.M.
6–6	3 vehicles	20.0	Drink—wrong side—improper pass	P. D. only	3:00 A.M.
6–11	Non-collision	2.0	Drinking—speed	1 injured	4:00 A.M.
6–12	Non-collision	17.0	Drink—asleep—speed	2 injured	7:00 P.M.
6–12	Non-collision	3.8	Drink—vehicle on fire	P. D. only	4:00 A.M.
6–18	Non-collision	12.7	Inattention—ran off road	P. D. only	5:30 P.M.
6–5	Non-collision	15.9	Car on fire	P. D. only	10:45 P.M.
6–22	Animal	4.3	Horse in roadway	1 injured	8:25 P.M.
6–25	2 vehicles	28.7	Asleep—rear end collision	P. D. only	2:45 A.M.
6–26	Fixed object	28.00	Tire blow out	P. D. only	3:00 A.M.
7–1	Non-collision	11.1	Speed—drinking	P. D. only	4:50 A.M.
7–4	Non-collision	21.9	Asleep	P. D. only	3:00 A.M.
7–5	Non-collision	14.5	Asleep	P. D. only	5:30 A.M.
7–10	Animal	17.1	Raining—too fast	P. D. only	10:30 P.M.
7–11	Animal	15.7	Raining—too fast	P. D. only	4:00 A.M.
7–15	Non-collision	24.9	Speed—fatigued	1 injured	2:15 A.M.
7–23	Non-collision	17.0	Speed	1 injured	5:30 P.M.
8–1	2 vehicles	21.4	Follow too close rear end	2 injured	5:30 P.M.
8–1	Non-collision	26.7	Speed—asleep	1 injured	11:50 P.M.
8–4	Non-collision	28.7	Drinking—asleep		5:30 A.M.
8–4	Non-collision	21.5	Speed—drink—asleep	P. D. only	9:15 A.M.
8–12	Non-collision	22.1	Speed	2 injured	7:05 P.M.
8–24	Non-collision	15.5	Faulty wheel	P. D. only	7:10 P.M.
9–5	Non-collision	11.2	Improper passing—out of control	P. D. only	4:20 P.M.
9–6	Fixed object	30.0	Asleep	P. D. only	1:00 A.M.
9–12	Animal	27.8	Horse in roadway	P. D. only	4:30 A.M.
9–18	2 vehicles	22.7	Improper park—drink	4 injured	9:15 P.M.
9–19	2 vehicles	6.0	Drink—wrong side road	2 injured	2:25 A.M.
9–20	Non-collision	5.4	Inattention—ran off road	P. D. only	7:30 A.M.
9–29	2 vehicles	23.8	Drinking—improper park	2 injured	7:30 P.M.
July 22 1954	Non-collision (FATAL)	25.3	Drinking—speed	1 killed, 1 injured	11:15 P.M.

The above table is not as firmly in favor of the shoulder stripe test section as the first tabulation; however, the accident rate is still three-to-one in favor of the section completely striped. It is also interesting that the single fatality during this period occurred on the section without a shoulder stripe. It might be noted at this point that U.S. 89 terminates at the international border of Nogales, Sonora Mexico. The town is quite a tourist attraction, with a gay holiday atmosphere. Many of the above accidents were caused by excessive drinking and late hours according to the highway patrol reports. One comment from an inebriate arrested for doing 85 MPH in the shoulder stripe section was "What's the matter, didn't I stay between the white lines?" He did, but he was an accident going someplace to happen since he immediately passed out when placed in the patrol car. This incident occurred after he had driven religiously in a straight line for fifteen miles between the centerline and the shoulder stripe. Needless to say he is now a great booster for shoulder stripes.

Shoulder Striping Costs $30 a Mile

Some of the old-timers in the department showed a strong tendency to discount the shoulder stripe idea and were even against giving the project a trial. It was their contention that drivers would look upon the shoulder stripe as a centerline and try to drive to the right of it and run off the roadway. We realized this might happen so the shoulder stripe was made different from the centerline stripe. As previously stated, the voids are twice as great at the shoulder. The standard centerline stripe has a forty-foot cycle. The shoulder stripe is approximately seven feet long with a thirty-three-foot void between dashes. Experience to date discloses no tendency to drive off the road on the right side of the shoulder stripe.

All striping in Arizona is of the beaded reflectorized type. The cost of the broken centerline stripe is approximately $25 a mile. The cost of the two dashed shoulder stripes is about $30 a mile, since the same amount of paint is used but the distance for the machine to travel is twice that required to place the centerline stripe. Some added expense was involved in placing the shoulder stripe since it was necessary in some places to sweep the edge of the pavement.

Part of the study in this project was an analysis of the lateral placement of vehicles on the standard forty-foot full width paved roadway. It was found on a section *without* shoulder stripes that the greatest volume (90 percent) of vehicles traveled a mean center of gravity distance of ten feet from the centerline. *With* the shoulder stripes approximately the same percentage drove eleven feet from the centerline. This bears out our original contention that the shoulder stripe, by definitely identifying the otherwise obscure edge of the pavement, moves traffic away from the centerline. It was also found that it moves a larger percentage away from the shoulder in an area four feet from the edge of the pavement. This certainly is a traffic safety feature since the lateral movement away from the centerline and the edge of the pavement helps reduce single car, side swipe, and head-on types of accidents.

Comments relative to the night-time value of the shoulder stripes have been most encouraging, especially on curves. The reflectorized stripes serve as two parallel guide lines and tend to increase night-time effective forward vision. The apparent meeting of the lines ahead of the driver provide an advance target while the two sets of broken lines help break the monotony of night driving by keeping the driver alert, awake and perhaps alive.

It is our customary practice to try to evaluate all research projects from an economic standpoint, to see if the benefits received by the motorist will offset the cost of the initial improvement plus continued maintenance. This particular problem is rather difficult and the proof of the economic value can only be obtained after more miles of shoulder stripes have been placed and records of total accidents and fatalities over a period of one or several years are evaluated.

In the past, there has been an excessive destruction of the common reflectorized guide markers. These markers are placed along the edge of the pavement on high fills, at all drainage structures, and around curves. It would appear that this damage should be greatly reduced when the new shoulder guide line provides a two-to three-foot safety zone, away from these markers. This possible benefit was not anticipated in planning the experiment, so a census of markers was not made. In future striping it is planned to count, or replace all previously damaged markers; then over a period of time

compute a damage ratio against the same section prior to striping. Another unanticipated benefit as previously touched upon should be a reduction in raveled edges. With these guide lines, indicating nineteen feet of driving lane, distressed cars and trucks should make better use of the eight-foot paved shoulder when they are required to stop.

As a continuing project it has been proposed that shoulder stripes be placed on the 1,184 miles of the interstate system in Arizona. After that has been done we will then stand back with our fingers crossed and hope that the fatality rate will decrease. At this writing the project appears very favorable.

Economic Effects of N.Y. Thruway

B. D. TALLAMY

Mr. Tallamy is chairman of the New York State Thruway Authority, a public corporation created by the 1950 Legislature to construct and operate a 562-mile toll expressway system. He resigned December 31, 1954 as State Superintendent of Public Works, a position he had held since October 1, 1948. A civil engineer, he has engaged in both public and private engineering and construction work since 1925. In January, 1945 Mr. Tallamy resigned as chief engineer of the Niagara Frontier Planning Board and withdrew from his private engineering firm to accept appointment as deputy superintendent of Public Works of the State of New York. He was promoted to chief engineer on July 1, 1947, and was appointed superintendent on October 1, 1948. He is a member of the American Society of Civil Engineers and National Society of Professional Engineers. He is a former president of the American Association of State Highway Officials. Mr. Tallamy's term as chairman of the Thruway Authority runs until January 1, 1960.

ANY attempt to assess the economic effects of a new express highway necessarily must proceed on certain basic assumptions and premises open to dispute. Studies relating to New York Thruway effects are no exception. In our rather limited survey of the benefits the Thruway has wrought to date, we have tried to avoid the pitfalls of "following-therefore-caused-by" reasoning. We have tried to establish beyond reasonable doubt that the economic benefits attributed to the expressway actually resulted from its construction, not from another factors.

It is premature to establish any sweeping conclusions from the limited data at hand. No part of the Thruway was in operation as a toll facility until last June when a 115-mile section was opened to traffic between Utica and Rochester. Subsequently this section was extended west to Buffalo, east to Albany, south to Newburgh and beyond. Now, with traffic rolling over most of the 427 miles between New York City and Buffalo, the economic shape of things to come is apparent, if not yet well defined.

In any discussion of the effects of the Thruway, comparisons are

inevitably drawn with the Erie Canal of the 19th century, which opened a new transportation artery from New York City to the midwest and made New York the Empire State. Land values rose $100 million within five years after the completion of the canal and New York State climbed from fourth place to first in population.

Sources of Information

Something of the same economic boom is following in the wake of the Thruway, according to the information assembled so far. The chief sources of data on the economic effects of the Thruway were:

1. District engineers of the New York State Department of Public Works.
2. The New York State Department of Commerce.
3. County, town and municipal officials.
4. Industrialists.
5. Newspaper and magazine articles.

By far the most valuable and thorough information on economic betterments along the Thruway route was supplied by the district engineers, who were directly in charge of the acquisition of right-of-way, the surveys, design and construction of the Thruway in their respective areas. These experienced and competent men who are thoroughly familiar with their districts were in a strategic position to observe at first hand the growth of new industry, new business and new housing as well as the rise in land values along the Thruway route.

The State Commerce Department, which has the assignment of attracting industries to New York, kept a check on new enterprises and the reasons why they located here. This information was made available to the Thruway Authority as were the observations of a number of local chambers of commerce and local governmental officials. Enterprising newspapers and periodicals turned up many interesting data and various leads which we were able to follow up. Industry itself frequently volunteered the information that the Thruway was a determining factor in the choice of a plant site or in the expansion of an existing industry.

From the mass of information assembled from these sources, the

Authority has been able to establish certain definite trends and to arrive at some sort of forecast of what the future may hold.

For instance, even at this early date, new and expanded factories, truck terminals, warehouses and similar enterprises valued at more than $150 million have developed along the Thruway route, especially near the interchanges. These are estimated to provide employment for 30,000 persons with annual payrolls totaling more than $100 million. The new enterprises range from a $4 million television assembly plant at Batavia in western New York to a $30 million shopping center at Yonkers.

Before detailing some of the more striking economic effects of the Thruway, it is worth mentioning that the construction program itself gave the state's economy a substantial boost. As of January 1, 1955, Thruway construction completed or under way provided 294 million man hours of employment and the total estimated payroll was upwards of $376 million. By the time the entire Thruway system is completed, it will have provided a total of 376 million man hours of employment with payrolls totaling $476 million.

All types of trades and professions are contributing to the Thruway construction effort. It takes designers, right-of-way experts, executives, supervisors, draftsmen, clerks, skilled machine operators, truckers, mechanics, road-building technicians and skilled and unskilled laborers. And for every worker on the job there are at least one or two others transporting or supplying steel, lumber, coal and coke, explosives, cable, pipe, tires, gasoline and fuel oil, and in the manufacture of construction machinery.

While it is not the purpose of this article to catalogue new enterprises along the Thruway, certain specific cases are worth exploring in some detail. For this reason I have broken these developments down into the districts of the Department of Public Works through which the Thruway runs.

Buffalo District

Buffalo, the second largest city in the state, is the present western terminus of the Thruway and the area immediately adjacent to the route has undergone profound changes. To quote Mr. Charles

Fichtner, executive vice-president of the Buffalo Chamber of Commerce:

"Immediately after the Thruway route became known, the chamber succeeded in interesting several firms in locations near it and these companies have invested or plan to invest more than $25 million for the construction of industrial, commercial, sales, and distributive establishments. This will be followed by proportionately larger housing and residential developments."

Up to now, new enterprises with annual payrolls totaling $3 million have developed along the Thruway on the fringe of the city. These include a huge shopping plaza, a steel fabrication plant, a meat packing plant and a number of smaller developments. Several new truck terminals are operating and others are planned with the long range prospect of making Buffalo one of the nation's greatest truck terminals.

According to Dr. Charles R. Waters, Buffalo District Engineer of the Department of Public Works, "It is apparent that the Thruway is already exerting a tremendous influence upon the economy of the area through which it passes."

Rochester District

Moving eastward along the Thruway, the Rochester District is experiencing a great transitional period in which land values have soared and new enterprises are mushrooming on what was once unused land. Although the Thruway passes several miles south of the city, its effect on Rochester and vicinity has been striking.

"During the last few years, Rochester has secured 76 new plants, 54 branch plants, and 195 additions or expansions of old plants," according to Elmer G. H. Youngmann, Rochester District Engineer. "We believe a good share of this new industry has been brought here because of proximity to the Thruway."

Around the West Henrietta Interchange leading to Rochester, land values have increased 700 to 1,000 percent. A cluster of gasoline stations and motels has developed near the interchange and the three adjoining towns of Henrietta, Rush and Brighton have established new water districts at a cost of $500 thousand each. Other

developments in the Rochester District include a $4 million television plant on a main Thruway feeder road at Batavia; a $1.5 million surgical instrument firm; a New York Telephone Company truck garage and repair station; a $2.75 million housing subdivision; and a construction drainage pipe manufacturer. A nine-county regional market, estimated to cost at least $10 million, is planned for construction in stages.

Syracuse District

Syracuse, sometimes called "The Show Window of the Thruway," is in the geographical center of the state and is connected to the expressway by five interchanges. Thruway construction was begun earlier and advanced more rapidly in the Syracuse District than in other areas of the state. The growth of industry kept pace with the construction program with the result that the northern periphery of Syracuse has a noticeable concentration of new enterprises convenient to the Thruway. New firms in this area employ some 17,000 workers and have an annual payroll estimated at $50 million.

Property in the vicinity of the interchanges has skyrocketed in value. A few years ago the state acquired land in this area for Thruway purposes at $500–$600 an acre. Today, adjacent land has been selling at $6,000 an acre and up. A group of Syracuse realtors bought up 571 acres near a Thruway interchange for an "industrial park" and now foresee potential construction totaling $25 million.

"From our investigations it is evident that many industrial and commercial concerns are negotiating for plant locations in the vicinity of the Thruway interchanges," according to William Robinson, Syracuse District Engineer.

Syracuse, situated as it is at the hub of the state with excellent transportation facilities of all types, poses a special problem in determining which new developments were attracted by the Thruway either wholly or in part. In any case, however, the area around the Syracuse interchanges is one of the state's fastest growing industrial centers and promises to develop even more rapidly in the months and years ahead. In addition to new plants, such companies as the Carrier Corporation and General Electric have expanded since the Thruway route was determined.

FIGURE 1. Thruway, six miles along the eastern outskirts of Buffalo in Cheektowaga, increases business in the suburban area. Land values have jumped seven times.

FIGURE 2. Interchange 29, connecting the Thruway with Route 10 at Canajoharie. The packing plant to the left added 80,000 square feet with the coming of the expressway.

FIGURE 3. In 1953, when the Thruway cut the old Erie Canal village of Fultonville in two, Fultonville expanded. The village is confident that the interchange, connecting with Route 148, will bring new business.

FIGURE 4. The Thruway's Hudson River $60 million bridge between Nyack and Tarrytown is scheduled for completion this year. The new Westchester-Rockland link is stimulating unprecedented activity in the two counties months before the first vehicle will cross.

Utica District

Along the Mohawk Valley—already pierced by the Erie Canal, two railroads and two state highways—industrial and commercial development on the Thruway is less striking than in other areas. However, a farm equipment distributor with an annual payroll of $100,000 has located at New York Mills, near Utica. The Thruway has a definite bearing on the choice of a site, according to company officials. Two new trucking companies also have established terminals there because of easy access to the Thruway. A baby-food company at Canajoharie has added a $350 thousand annex and a new warehouse because of the quicker truck transportation to New York the Thruway offers.

At Fultonville, where the Thruway bisects the village of 900 population, the construction of the Thruway was originally viewed as spelling economic disaster. Today, with the Thruway completed, the village is in the soundest financial position in its history, with its bonded indebtedness retired and more property on its tax rolls than before the bulldozers moved in. Nearly every home and business establishment disrupted by the Thruway has been relocated in the village. Two new service stations are in operation and three restaurants serve the village where only one existed before the Thruway was built. There is a new machine tool plant, a relocated milk plant and the village is conducting an active campaign to attract other new enterprises.

Albany District

The Albany District has a great potential for industrial and commercial expansion but the economic effects of the Thruway are not yet clearly defined. New housing developments are planned near the Thruway interchanges, a new motel costing $850 thousand is in operation and another estimated at $500 thousand is planned. Several new truck terminals and warehouses have been located on a Thruway feeder road. In Schenectady County to the west, a new chemical plant costing $1 million has been constructed near the Thruway and other manufacturing and retail establishments are proposed. A $4 million development of 376 homes near the Thruway interchange leading to Schenectady is planned.

Poughkeepsie District

In the Poughkeepsie District, which covers nearly all of the Thruway between Albany and the New York City line, there has been a notable rise in land values and a mushrooming of new enterprises.

A new business machine plant with an annual payroll of $4 million is under construction 300 yards from the Thruway near Kingston. The Newburgh area has a new expansion bolt plant and a metal fabricating concern. Also in the general area are six other new enterprises, including a tool and die plant, an electric parts concern, and a television antenna manufacturer.

Thruway construction removed taxable property valued at $700,000 from the tax rolls at Tarrytown but has already added $1,000,000 in new assessments. According to Mayor Edward N. Vetrano, new or proposed construction in Tarrytown totals almost $50 million. At Yonkers, farther south, the Thruway took $2,500,000 of taxable property but added $20 million in new construction.

The largest single new venture along the Thruway in point of investment is the new Cross County Center at Yonkers. Built at a cost of nearly $30 million, it has 3,000 employes and an annual payroll totaling $4 million. One of the most cogent reasons for the choice of the site was the availability of an important Thruway interchange at that location. The project covers 71 acres, has parking space for 5,000 cars and such unique features as a 125-bed private hospital.

General Economic Effects

From this brief look at specific industrial, commercial and residential developments along the Thruway, it is obvious that a kind of beneficial economic revolution is already under way along the route and especially near the interchanges. The extent of this revolution will not be fully known until the entire 562-mile Thruway system is completed, or at least under construction.

Looking at the broad picture, New York State's travel and vacation business, estimated at $2 million annually, stands to gain substantially from the Thruway. As in other states, travel has become a big business in New York and the tourist dollar splits up into many fractions, nourishing every segment of the economy. Studies made by

our State Department of Commerce show that 11 percent of the typical tourist spending goes to clothing stores, 9 percent for automobile expenses, 8 percent for other forms of transportation, 5 percent for refreshments, 4 percent for equipment, 5 percent for souvenirs and 9 percent for amusements. Nearly half the travel dollar, 49 percent, goes for food and lodging and the greater part of this expenditure is passed on to retailers and wholesalers for supplies of various kinds. Ultimately the impact of the dollar spent by a traveler is felt by farmers and manufacturers far removed from the area where the money was originally spent.

Again, it is too early to show that the Thruway has rung up any new sales in the travel and resort industry. However, we do know that the Thruway has proved to be an outstanding tourist attraction in its own right and has drawn countless new visitors from other states and Canada in the early months of operation. The Thruway crosses, or borders on, most of the state's vacation regions and cuts the travel time to others. Ease of driving, quick and convenient means of access, are great stimulants to travel and the Thruway is bound to have a tremendous and lasting effect on the vacation industry in the years ahead.

On the debit side, there have been complaints that the Thruway has siphoned tourist dollars away from small businesses on parallel routes. There has been a tendency in some quarters to view it as a long chute to whisk the tourist on a non-stop, 60-mile-an-hour race through the state.

However, this objection has very little basis in fact. Along the 427-mile route from New York City to Buffalo, fifty-three convenient interchanges lead to all of the communities and vacation regions of the state. With the completion of the entire 562-mile system, additional interchanges will bring every community and area of the state within easy driving distance of the Thruway. In our first six months of operation, the average passenger car trip was 48 miles, indicating that only a very small percentage of travelers drive the entire length of the expressway. Moreover, the Thruway will have no sleeping accommodations and the long-range effect of the increased travel it encourages will be to better the economic position of hotels, motels, restaurants and similar enterprises off the route.

We have no accurate measure of any drop in business along

parallel routes since the opening of the first Thruway section. Operators of some motels, restaurants and filling stations have reported a loss of business. Others have found it substantially increased. It is not clear, however, how much these fluctuations are due to the opening of the Thruway and how much to general economic conditions, or to temporary construction on the parallel route or to some other factor not germane to the question.

In any event, experience in other states appears to demonstrate clearly that any initial loss of business resulting from a new expressway is more than compensated in a relatively short period. As traffic is diverted to the expressway, other traffic in turn will return to the relieved parallel highway from more distant or indirect routes, or be generated because of the new available route capacity. This will quickly restore the traffic volume on the parallel route to an amount in reasonable relationship to its safe carrying capacity.

The Thruway is expected to exert many long-range economic benefits not covered in this brief survey. For instance, we know from test runs that commercial vehicles, especially heavy trucks, can make substantial time and dollar savings on the Thruway. These savings may well be passed on to the consumer. We know that ease of commuting is already giving rise to new satellite communities in areas formerly too far removed from business and industrial centers. We know that farmers are already finding wider markets for their produce and are able to deliver it fresher from the fields and dairies. These benefits point to a bright new economic future for the Empire State because of the transportation revolution the Thruway has brought.

Park-Ride in St. Louis

O. W. REXFORD

Mr. Rexford, vice-president and operating manager of the St. Louis Public Service Company since April, 1954, began his transit career when he joined the public service organization in 1946 as executive assistant. Soon after joining the Public Service Company, he became personnel director, in 1948 was appointed assistant operating manager, and in July, 1952, was made operating manager for the company. Prior to his army service from 1942 to 1946, he had been manager of the St. Louis office of the First Boston Corporation investment bankers. Mr. Rexford is a member of the Personnel and Accident Prevention Committee of the American Transit Association, vice-president of the Safety Council of Greater St. Louis, a member of the Board of Directors of Bethesda General Hospital, and has been active in other local civic affairs.

PROVIDING express bus service to a city's central business district from perimeter parking lots has been given a full-scale trial in St. Louis. The results of this experiment—which we call park-ride—indicate that extensive application of the perimeter parking principle would provide a substantial contribution toward relieving the traffic congestion that plagues American cities.

The purpose of St. Louis Public Service Company in experimenting with park-ride and with other special services is, of course, to win motorists away from their cars and back to riding transit. But our interest goes beyond the short-run objective of collecting the fares of passengers who use these special services. Our primary interest is in the economic well-being of the St. Louis downtown area —to which our own future as a business enterprise is irrevocably tied.

St. Louis, like most mature American cities, is concerned about maintaining the economic vigor of its downtown district. This is a matter that affects every individual and business in the St. Louis metropolitan area, for everyone has a stake in the health of this district. It is the heart from which the economic life-blood of the entire area flows.

And no industry has any greater stake in the economic health of the downtown district than transit. It is extremely doubtful that any

major mass transit company operating in a metropolitan area could long survive the loss of its downtown business. St. Louis Public Service Company has twenty-one regular bus and streetcar lines and ten express bus lines—plus numerous special lines— serving downtown. We carry about 150,000 people into and out of the central district daily. Without this basic, high-volume business, we could not afford to continue to serve outlying areas.

Along with having a vital economic interest in the health of the downtown district, we are convinced that public transit, if given the opportunity, can solve one of the major problems confronting the district—the problem of moving people swiftly, efficiently and economically.

Moving People Rather Than Vehicles

Since we define the problem as one of moving people rather than vehicles we seriously question proposals that would serve to aggravate the problem by encouraging greater use of automobiles in the downtown district.

In St. Louis, a report made to the mayor's off-street parking commission a few months ago recommended the construction of five new downtown parking facilities, with a combined capacity of 2,100 cars at an estimated cost of $5,575,000. And just a few weeks ago, it was suggested that the city spend $10 million for an underground garage that would accommodate 3,221 cars.

At one and a half persons per car and assuming a 50 percent turnover—that is, each stall would be used one and a half times daily—these combined facilities would accommodate only 12,000 persons at a cost of more than $15 million. This is in contrast to the 150,000 persons a day moved into and out of downtown by transit.

We feel that intelligent use of transit provides a real solution to the problem at a small fraction of the cost of building downtown garages—garages that would generate more congestion on our already over-crowded streets.

Assuming that greater use of transit is the most effective way of reducing downtown vehicular traffic, the problem is one of converting commuters and shoppers from motorists to transit riders. The trend over the last several years has been the other way. Reversing it is a tough job.

There are many things that cities can do to help reverse this trend by enabling transit to offer a faster and therefore more attractive ride. They can take steps to ease central area traffic congestion and in that way increase the speed of mass transit. These steps include curb parking restrictions, more one-way streets, pedestrian control, synchronized traffic signals, no left turns, restrictions on commercial traffic during rush hours, the exclusive use by mass transit of curb lanes and entire streets. They can also help by making special provisions for transit in the design of expressways and by taking transit out of the economic and tax "whipping boy" class.

A few of these steps have been taken in St. Louis as the result of the adoption of a master traffic plan, and others are being planned. Already, they have resulted in speed increases on some transit routes.

Transit Must Lure Motorists

But important as these arrangements are, they alone are not sufficient to lure motorists back to transit. Transit has to find ways of adapting its service to present-day needs, ways of making riding a bus more convenient than driving a car, and ways of persuading motorists to give transit a try.

And although the transit industry is convinced that intelligent use of mass transit is the answer to the problem of traffic congestion, it obviously has not convinced the public and their representatives. To obtain the help the industry needs to operate at peak efficiency—such as exclusive use of curb lanes or of entire streets—it is apparent that the industry will have to demonstrate through its own actions the validity of its arguments.

This, by way of background, is basis for St. Louis Public Service Company's experiments with a number of different kinds of special services, including park-ride, the results of which have been most encouraging.

There are three main ways in which the park-ride principle can be used.

1. By providing parking facilities at the ends or along the routes of express or rapid transit lines.

2. By providing short-haul shuttle service from parking facilities located within a few blocks of the business district.

3. By providing express service from parking facilities located at "half-way" spots around the perimeter of the downtown area.

We chose the third type for our experiment because we believe it offered the greatest possibilities for acceptance and growth. A motorist driving to a lot at the "half-way" point does not have to fight the heaviest traffic congestion, and yet the bus ride is short. He is not as tempted to drive all the way into the downtown district as he might be if the lot were adjacent to the district. And competition from walking is eliminated.

Perhaps the most important factor is that locating the lots beyond the area of greatest congestion gives the motorist an opportunity to make the best use of his automobile.

Forest Park Affords 1600 Car Spaces

We selected as our first location Forest Park, a large city park five miles due west of the central business district, and persuaded the city to permit us to use parking areas constructed to serve patrons of the St. Louis Municipal Opera at night during the summer months. We pay no rent to the city, but we pay for the services of city watchmen who guard the lots. There are three such parking areas with a combined capacity of about 1600 automobiles. The two smaller lots, accommodating a total of some 600 cars, are at the lower end of the Municipal Theatre along heavily traveled park drives. The larger-capacity "upper" lot is off the beaten path and it was for this reason that we started with the two lower lots.

Operations started on November 16, 1953 with non-stop downtown service every five minutes during the rush hours only. All-day service was started on December 7 of that year, during the Christmas shopping season, with fifteen-minute service during the middle of the day. It proved successful enough to retain.

Our running time is seventeen minutes to 12th street and about twenty-two minutes to 4th street (the eastern terminus). We charge a roundtrip fare of 35 cents. There is no parking charge.

The buses are painted in a different color from our regular fleet. They carry flags and large painted signs on each side advertising the park-ride service.

On the first day of operation, we had about 100 cars on the lot

FIGURE 1. The first Park-Ride operation of St. Louis Public Service Company started from two of the smaller parking areas used by the St. Louis Municipal Opera in Forest Park. One of these lots is pictured above.

FIGURE 2. The growth in patronage of the Forest Park Park-Ride service made it necessary to move to the larger 1,000-car capacity Municipal Opera parking lot in March, 1954.

and 130 passengers. Use of the service has increased steadily and the operation now handles 600 to 800 cars and from 800 to 1,000 daily passengers. As patronage grew, it was necessary to move the operation from the two smaller lots to the large-capacity upper lot. The immediate result was a loss of some 20 percent in patronage due entirely, we believe, to the less favorable location of the upper lot. However, within a few weeks this loss was recovered and patronage continued to grow.

During the third month of the experiment, we hired a market research firm to conduct a personal interview survey of park-ride customers. The principal questions referred to origin and destination, purpose of the trip, how the customer first learned of park-ride, and how the customer traveled downtown previously. The most important finding was that 70 percent of the park-ride customers formerly made their trips downtown exclusively by automobile and that over half of the remaining 30 percent previously divided their trips about equally between transit and automobile.

Among other findings, the survey disclosed that 57 percent of park-ride customers were men and that the worker-shopper rate was about three to one.

Although not ideal, the location of Forest Park has many advantages for a park-ride operation: It is convenient to a large residential area; it is on one of the main routes downtown; it is at a dividing point between city traffic and suburban traffic; and it is free of parking for other purposes.

The success of the operation, we believe, has been due in large measure to the convenience and speed factors. These items were featured in an intensive promotion campaign used to inform the community about the service and to persuade motorists to try it.

Letting the People Know

Newspaper and radio advertising were used over a period of two weeks to announce the service. News stories were issued from time to time during the first few months, reporting the progress of the experiment and keeping the public posted on any changes. Among these were reports on the extension to all-day service, on opening a second lot, and on moving the entire operation to the upper lot.

Newspaper, radio and TV played park-ride as a top local news story for several weeks. In addition, our two metropolitan daily newspapers carried eight favorable editorials on the experiment during the first three months of operation.

Our basic information piece was a simple four-page pamphlet that received wide but pin-pointed circulation. It explained how the plan worked and contained a timetable and map of the bus route. Routes to the parking area were also clearly marked.

First, we distributed 200,000 pamphlets in "take-one" holders in our own vehicles. We then wrote a letter to some 5,000 business and professional men, including all of the downtown area's large employers. In addition to the pamphlet, we enclosed a complimentary ticket and asked the recipient to be our guest for a trial ride. We also included a return postal card that could be used to request additional pamphlets for distribution to their employes. The response was unusually good.

A second and very effective mailing was made through the cooperation of the Missouri Automobile Club. In this case, the letter was signed by the president of the club and mailed to some 14,000 members—selected by postal zones—who live in the areas from which the park-ride service logically draws. This letter, too, contained a complimentary ticket and a pamphlet.

Promoting the Bus Service

We also used the survey of riders to promote the service. At the close of each interview, the respondent was handed a thank-you note in the form of a postal card that could be used to suggest names of additional park-ride prospects. We received hundreds of names in this way—and, of course, followed up with an appropriate letter and a complimentary ticket.

Beyond attracting riders to park-ride, the promotional program has had an important secondary effect. By turning the bright spotlight of publicity on park-ride, transit customers and potential customers throughout the community became aware of its possibilities.

This made it easier to suggest in our advertising of other services that motorists use the park-ride principle by parking their cars along regular transit routes and completing their trip by transit. This was

emphasized in promoting two special summer services—the Red Bird Express Service to Busch Stadium for the home games of the St. Louis Cardinals and the Municipal Opera Express to the Municipal Theatre in Forest Park.

In many cases motorists have been using some of our lines on a park-ride basis without any special promotion on our part. This is particularly true along our express lines to downtown St. Louis. A number of commuters park their cars at the suburban ends of these lines and take the express service to work. We are hoping to stimulate this practice by expanding the parking facilities wherever possible.

Three Auxiliary Lots Opened

Encouraged by the success of the Forest Park operation, we decided to conduct experiments on a smaller scale in north and south St. Louis. Although the lots selected are not ideal in every respect, they will serve to test public appeal for this type of service in other sections of the community.

Three such auxiliary lots were opened late last fall—one of which is on our own property adjacent to the company's North Broadway division office.

As an interesting sidelight at the latter location, we are experimenting with the use of an automatic parking gate, now commercially available, at the entrance of the lot. Although no parking charge is made in this case, the gate serves to reserve the lot for the exclusive use of park-ride customers—which is an important factor in an area surrounded by industrial plants. As the motorist approaches the gate to enter the lot, his car passes over treadles which automatically raise the gate. Another set of treadles lowers the gate after him. On leaving the lot, however, the patron must deposit a token in a receptacle, which can be reached from the car window, to operate the gate. The token is given to him by the bus operator. The gate can also be operated by a quarter—as a parking fee for "poachers"—or by a special sensitized card which may be issued later to regular customers.

The experience gained from the use of this device may prove helpful to subsequent park-ride installations where this mechanical "attendant" could be used to collect nominal parking fees.

It is too early to pass judgment on the specific success of the new operations. But sufficient experience has been gained with the overall plan to know that the principle is sound.

At the present time, park-ride is responsible for keeping about 1,000 motor cars out of downtown St. Louis every day. The important thing is that the people riding in these cars are still going downtown, but they are doing so in a more convenient way—and they like it. Moreover, they are helping to relieve traffic congestion in the central business district.

Transit Needs Aid for Sites

All of this has been accomplished by a full-scale enterprising effort by the transit company. It has been shown that under proper conditions and with adequate promotion motorists in large numbers may be persuaded to leave their cars outside of the congested district and complete their journey by transit.

To capitalize on the results of this experiment in terms of traffic relief for downtown, the transit company must be aided by other elements of the community. Transit has no desire to enter the parking business. But serious consideration should be given to the diverting of funds now suggested for additional parking facilities in the downtown district to the assembly of sites around the perimeter, predicated on the park-ride principle.

It is just a matter of economic good sense. We referred earlier to the proposed expenditure of some fifteen million dollars to provide off-street parking for 5,300 cars in the downtown district. Aside from the engineering fact that these facilities would generate additional congestion in the very area we are trying to relieve, the cost per person served is almost fantastic.

For one-tenth of this amount, with the aid of transit, all of these cars could be parked on the perimeter—thus preserving the freedom of circulation in the downtown heart which is vital to the welfare of the entire community.

The British Floor Space Index Use in Calculating Parking Demand

NOEL DANT, M.R.P., M.ARCH., M.T.P.I.

Mr. Dant was born in London, England, and was educated in Britain and the United States, attending London, Edinburgh, Yale and Harvard Universities. He was awarded six degrees in city planning and architecture during this period as well as being the recipient of five medals, two scholarships, and two traveling fellowships. He is an Associate of the Royal Institute of British Architects, and a Member of the Town Planning Institute of Great Britain. Mr. Dant has been Town Planner for the City of Edmonton, Alberta, since 1949.

IN AN EARLIER article,[1] the author mentioned that an adaptation of the British Floor Space Index method could provide a useful tool for the planner in assessing potential off-street parking demands in central urban areas, particularly those slated for redevelopment.

It must be remembered that the needs for off-street car parking are generated solely by the buildings themselves and by the expected employees, patrons, customers and visitors having business to transact in the buildings. Provision for off-street car parking cannot, in the ideal, be separated from the building which generates such parking demand. Thus, in the original concept of the planner's design, the buildings and car parking space should be integrated to such a degree that they are tantamount to the same thing.

The British Floor Space Index method was first conceived, not as a tool for assessing parking demands, but rather as a guide to the planner engaged in preparing central urban redevelopment schemes —the better to provide such proposals with adequate light, air and ventilation and to prevent over-development or under-development on the land contained in his scheme. It is easier and more economical, although not essential, to base such proposals on the super-block principle, rather than to treat the original and smaller blocks sep-

[1] "A Resume and Some Implications of a Canadian Parking Survey," Traffic Quarterly,- April, 1954.

arately or to use existing streets more or less as they were under the original and out-moded development.

Off-street parking is only one additional requirement to be considered by the planner before embarking on his design; it should and could be included with all the other requirements needing attention at the outset of his scheme. The single block as well as the superblock can thus be treated for potential car parking accommodation, insofar as the planner has the requisite legislation and a sympathetic local authority to see that such plans can actually be implemented on the ground. Before discussing the adaptation of this F.S.I.[2] method for assessing potential parking demands, an explanation of the F.S.I. method itself is necessary in relation to a development scheme for a central urban area, as proposed by the British Ministry of Town and Country Planning[3] (now reorganized as the Ministry of Housing and Local Government).

The Field Survey

Before a redevelopment scheme can be organized by the planner, a field survey of existing uses of the land involved must be undertaken.

Central urban areas contain the major part of the business and civic life of cities and towns and great sums of public and private money will be expended on their redevelopment in the coming years. It therefore follows that the survey, which will greatly influence the manner in which these sums will be expended, must provide basic information in sufficient detail.

If possible, this site survey should take into account a larger amount of central area land than is being re-planned; for a worthwhile redevelopment plan is intended to provide good siting conditions for approximately the right amount of each suitable central land use. The plan must involve some redistribution of existing uses, both inside and outside the proposed redevelopment area, in terms of both land areas and building accommodation. This larger area might be known as the survey area, to distinguish it from the smaller redevelopment area.

Once this picture has been obtained, the planner will be able to

[2] Floor Space Index

[3] A full explanation of this method may be found in the advisory handbook on the *"Redevelopment of Central Areas,"* H. M. Stationery Office, London 1947.

decide to what extent a particular land use should be increased or decreased in the light of particular factors.

Apart from different existing uses of the land, the survey will need to ascertain all existing buildings deteriorated beyond repair, the probable length of useful life still left to other buildings, the land areas of the different uses, and the amount of floor area available for each use within each building. As some buildings have a different use for the ground floor from that of upper floors (and the ground floor is usually the largest floor in the building), it is also desirable to have the ground floor area of each building shown on the survey. For simplicity, such areas usually include all wall thicknesses, corridors, halls, staircases, elevators and basements. A last piece of necessary data in the case of shops and stores is the foot-run of each shop frontage.

After a field book has been prepared with the above data entered in it for each building, cross-referenced to a large-scale survey map of the block or area, all buildings should now be grouped according to three headings:

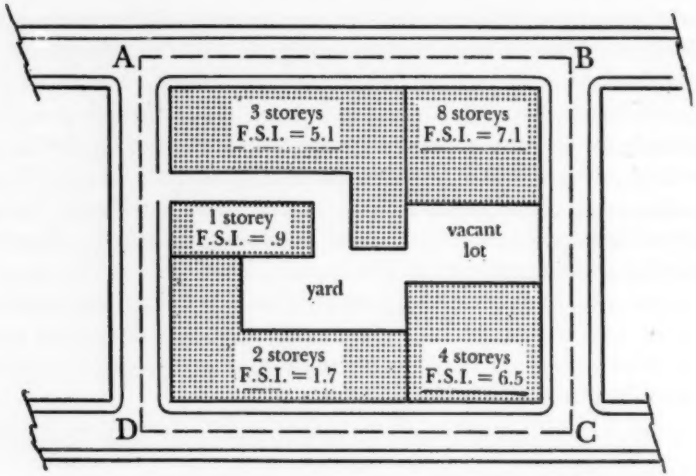
1. Buildings which should be retained because of architectural value and historic interest;
2. Fairly new buildings, not likely to be obsolete within the next thirty years;
3. All other buildings.

Because many central areas to be redeveloped show a peppering of mixed uses, the data of the field survey should also be broken down to obtain totals for each land use—dwelling houses, other residential buildings, schools, shops, offices, wholesale and warehouse buildings, public buildings and places of assembly, light and heavy industry and miscellaneous buildings. The survey data thus elicited will show total existing floor areas for each use but it will not show these areas in relation to the appropriate site areas; in other words, *it does not show the density of building accommodation,* and hence its degree of over-crowding or under-development.

The Floor Space Index Defined

The Floor Space Index, therefore, is the ratio between the total area of all floors contained within a building and the area of the

plot of land on which the building stands. In calculating the plot area, the British include half the width of all streets circumscribing the block. It should be noted that the F.S.I. is *not* a guide to the number of storeys in a building or to its height.



Total Floor Area within A, B, C, D.	=	31.2	Acres
Site area within A, B, C, D. (Including half the width of circumscribing streets)	=	6.0	Acres
∴ F.S.I. for Block A, B, C, D.	=	5.2	Acres

FIGURE 1.

As an example, a building of uniform height of six storeys on all street fronts with a central courtyard may provide for an F.S.I. of 2.0; whereas another building on the same amount of property, yet only covering a smaller portion of this property, may be as high as ten or more storeys and yet still provide an F.S.I. of 2.0.

In summary, therefore, the F.S.I. may be considered to offer the simplest means of determining, comparing and controlling the building accommodation contained or to be provided within the land areas of any size from the survey area or proposed central redevelopment area as a whole, down to the single plot or block.

The Redevelopment Plan

The decisions which now have to be made in preparing the redevelopment plan itself are of three kinds:

1. The kind of use for which the plan should provide;

2. The amount and distribution of the floor space and land which should be provided for each use; and,

3. The layout of streets, both main and local within the area to be planned.

These three kinds of decision are of course intimately bound up one with the other, and the preparation of the redevelopment plan is essentially the many-sided process of adjustment between them.

For the purpose of this article, it is not necessary to go into detail to describe the preparation of the plan which these decisions indicate.

After the kinds of uses allowable in the plan have been decided, it is only necessary to state that the proposed densities of building accommodation will control the size of the redevelopment area in effect, and perhaps more than any other single factor, its efficiency and convenience. If the redevelopment plan is to be successful, suitable floor space indices must be decided for all street blocks in the new plan and developers must be required to adhere to them by appropriate regulations. If this is not done, accommodation may become concentrated in one portion of the area and lead to a breakdown of the traffic system and of the whole plan.

The F.S.I. applying to an individual building, plot or block would leave the developers free to decide whether to build a high building on a small portion of his land or a low one covering most of the land. Insofar as possible, this freedom should be preserved but it must not result in a new building's depriving any existing adjacent building on a neighbourhood plot of its fair share of daylight and ventilation. Although outside the scope of this article, a new method of daylighting control has been adopted in Britain, which prevents buildings from overshadowing one another and at the same time preserves for developers considerable freedom as regards the block form of their building.

One might summarize the situation thus: In the case of retail shops, for instance, under a proposed F.S.I., the developer would

probably prefer a lower type of building covering most of the available frontage of his site, for the sake of "shopping continuity of facade," but in the case of an office block under a similar F.S.I., the developer would be wise to choose a higher building with more space around it (i.e. the modern trend toward office buildings is toward such open-planning) for purposes of better access, amenity and convenience. In both examples, provision of off-street car parking would be an integral part of both the F.S.I. and the resultant relation of mass to site of the building.

The Parking Function

As suggested earlier, there is a marked trend in the preparation of modern redevelopment plans to adopt the super-block principle as being not only the more economical approach to a large redevelopment scheme but one also possessing greater possibilities and scope for solving potential traffic bottlenecks, parking facilities, convenience of egress into the area itself, and making for a more beautiful or aesthetic conception of the project. Thus a real opportunity is provided for more "open-planning" of one building in relation to its neighbours.

This super-block—open planning approach also solves a very real problem that the planner and the administrator have to cope with, as regards the enforcement of off-street parking for new buildings when such provision is made a regulation of the local authority. A trend to this provision is noticeable amongst local authorities these days. Certain cities and towns which earlier have adopted such mandatory regulations generally provide for off-street parking on the plot basis. In practice, this has proved, if physically possible, to be uneconomical, unfunctional and a waste of land, up to a point; in other cases, frankly impossible if the plot was small.

It is improbable that as long as much of the property of our central areas is owned on a lot basis, such a solution towards provision of off-street parking facilities would ever be really successful. I believe that only if we deal with off-street parking on a block—or better still super-block—basis, can we provide a realistic answer to the downtown parking problem.

In most practical redevelopment proposals in central areas which I have had the opportunity to study, the land is bought and as-

sembled either by the local authority or the redevelopment corporation, or by other similar means (grants, loans or subsidies from senior governments). Thus the consideration of a plan on a lot basis is eliminated. Even if it is not, signs point to the desire of business owners in a block to sink their various individualities when it comes to providing off-street parking and to co-operate with one another. If one or any of these above approaches to integrating the parking problem into a redevelopment scheme fails, then I fear there is no real solution to providing for adequate parking and the application of the British F.S.I. method becomes useless.

Even in the downtown areas, not slated for redevelopment by a large plan, but where vacant lots or obsolete buildings are demolished to make way for new, to allow such new buildings to be re-erected without proper provision for parking is to court trouble. This way of developing is merely one of piece-meal expediency and will never be ultimately satisfactory. The only good answer in such case is to zone for and allow one good multi-storey parking garage per block, if land is available, designed to accommodate all existing and potential parking generated by the block when the block has the requisite F.S.I. applied to it. It has been found generally unwise to locate parking garages at a greater distance than 800 feet from their source of demand, preferably much less.

In considering the economics of such a group-owned parking garage, one must remember that in any downtown property it is from the ground floor that the greater portion of the value of the land is derived. The use of part or all of the ground floor of a multi-storey parking garage for retail stores is one means of defraying land rental or taxes for the rest of the building.

Standards for Off-Street Parking

A recent survey of 185 American and Canadian cities and towns which have already adopted standards of some form for regulating the minimum number of mandatory off-street parking stalls for new buildings, gives us the following information. (See Table I). Included also for comparison is a summary of standards suggested by Mogren and Smith.[4] Included as well are the confirmed City of Ed-

[4] *"Zoning and Traffic,"* by Mogren and Smith. Eno Foundation for Highway Traffic Control 1952, p. 70.

monton standards in Column 7, and in Column 8 is given the actual Edmonton demand ascertained from the parking survey of 1952. Columns 3, 4 and 5 are those recommended by Mogren and Smith.

Criticism of the adopted Edmonton standards shown in Column 7 has been made that they are excessive, uneconomic, unreasonable, too severe, wasteful and discriminatory.

A comparison with Columns 4, 5 or 6 shows that Edmonton's standards are considerably milder and lower than in the majority of cities analyzed by Mogren and Smith. In any case, the real crux of the matter is not so much one of comparison with what other cities have seen fit to adopt, but rather the revelation from the downtown survey itself in Column 7 that in more cases than not, the actual demand in Edmonton is much higher than the standards adopted; that the standards are far too lenient to take care of anything like the actual parking load generated.

To go further, short of adopting a maximum floor space index for either building or block or area as building after building is built skywards, wall to wall, the actual floor space index calculated for an existing block would be found far higher than the maximum which the block could functionally support, without giving rise to traffic blocks, lack of space and accessibility around the buildings. A more efficient and convenient urban structure would result if a maximum floor space index were imposed immediately and enforced through the years, as demolition, obsolescence and redevelopment take their normal course.

Concerning the selection of suitable standards in a city which has not yet adopted any—and such standards would have to be adopted if the floor space index method were to be applied—these standards can only be suitably arrived at for the specific city after first ascertaining what the demand is in its total downtown area, according to use and location. A method for eliciting these factors was treated more fully in my previous article in the Traffic Quarterly or, better still, in a more comprehensive way in the final report on the subject presented to the City Council of Edmonton, Alberta.[5]

We come now to selection of appropriate F.S.I.'s for different

[5] Edmonton Downtown Parking Survey and Report—and—The Nature of Traffic and Parking 1952 (Obtainable from the Town Planning Department, City of Edmonton, Alberta $3.00 per set post free).

land uses. To my knowledge, the F.S.I. method has not as yet been tried out in the United States or Canada. Suitable maxima for British cities and towns around a quarter of a million are suggested in the Advisory Handbook, referred to before. However, it will be appreciated that the general form of downtown areas differs considerably in various parts of the world. Partly owing to the way of life springing from tradition and historic evolution, partly owing to the poor stabilizing qualities of sub-soil and drift geology in Britain, and partly owing to more rigid building codes of longer application than those in the Americas, European downtown areas exhibit for the most part buildings of lower heights and fewer number of storeys than their counterparts on the American continent.

The Application of Floor Space Index

For these reasons, it will probably be found that the British F.S.I.'s suggested standards in the Handbook are considerably lower than would be applicable here. A further valid reason for this speculation would be the heavier automobile ownership per capita in the Americas than in Europe.

The suggested F.S.I. to be applied in cities and towns of around 250,000 in Britain exhibiting normal variations in F.S.I. as between one zone and another are:

(a) For shop zones	1.5	Yielding building of average height with ample parking.
(b) For office zones	1.5 to 2.0	Yielding moderately high buildings, without causing any serious difficulties in parking, access and layout.
(c) For wholesale-warehouse zones	2.25	A large part of the buildings in this zone are used for storage and thus do not rate a high standard of daylighting or parking.
(d) For public building zones (and places of assembly)	—	As the storey height in such uses, an auditorium for example, is far in excess of average heights for shops, offices and warehouses and as this use requires special open siting for the buildings, the F.S.I. is not a suitable instrument for such zones.

(e) For light industrial zones	2.00 to 2.5	These zones are essentially for clusters of smaller types of light industrial work shops and offices.

We are currently working on a set of applicable figures for Edmonton but the study is not yet completed. There are, however, some general remarks regarding the F.S.I. applicable in any part of the world, which are pertinent to this subject.

In the first place, before a redevelopment plan can be adopted, the basic survey will have already thrown up the existing F.S.I. of the original buildings and land to be re-planned. These F.S.I.'s can be calculated for the whole area under the plan; the survey will also throw up the F.S.I. for the totals of each of the main land uses in the area. From these, we would eliminate those uses no longer considered desirable in central urban areas—residential buildings, heavy industrial buildings, schools and so on.

A rough calculation of this kind might be made as follows:

1. Total floor space of all kinds both occupied and vacant within the redevelopment area, as shown by the site survey . . . . . 630 acres

2. Gross site area of the redevelopment area . . . . . 315 acres
   ∴ F.S.I. of redevelopment area 2.0

3. Total floor space of only those uses desirable to be retained in the redevelopment area, although their locations may differ . . . . . 460 acres

   ∴ Acreage required for this floor space at the original average density of development (i.e., F.S.I.) . . . . . $\frac{460}{2}$ or 230 acres

From this rough calculation, we could deduce alternative facts:

a. That if the original F.S.I. is considered desirable to retain in the new plan, we have a saving in total site acreage in the redevelopment plan of 85 acres (315 minus 230), which could in turn be developed at the same F.S.I. and so provide more floor space for the desirable uses only than was possible on the original site area of 630 acres.

OR:

b. That an increase in the F.S.I. could be tolerated over the total

area (if the original F.S.I. was found to be uneconomically low) and the corresponding increase in desirable uses spread over the whole site area, sectionally or otherwise (on the average, a new building replacing an older one of like use will tend to be larger than the one it replaces).

OR:

c. That a decrease in the total F.S.I. would be desirable (if the original F.S.I. was found to be inefficiently high and productive of congestion or over-development) and the same amount of floor space of retained uses found in 3. above could then be more efficiently spread over the total site area of 630 acres.

OR:

d. That parts of the redevelopment area no longer required under deduction (a) be removed from consideration of the plan if found to be on the periphery of the central urban area, and incorporated into a different plan altogether, yielding development of uses not normally associated with central areas but more surburban in character.

And so on, with many forms of variations, due to sectional or total site adjustments.

As a general rule, proposed F.S.I.'s for those land uses retained in the new plan, even if their relative locations differ, should rarely be less than they were found to be in the survey, unless parts of the survey area possessed such an absurd degree of overcrowding before that a correction is necessary. It is important to study the reason for any traffic bottleneck previously existing in the area, with a view to eradicating it in the new plan. But this bottleneck may not necessarily have arisen through over-development or from high density of accommodation in the old area—it may indeed have been derived from purely a matter of faulty street and intersection design. However, overcrowding generally exhibits a local degree of urban congestion of traffic in the immediate environs.

The floor space indices most appropriate for a city or town will also depend on topographical and other local conditions, including the type of city (an older market town would have F.S.I.'s somewhat lower than a new industrial town of the same population). Another guide to appropriate selection of F.S.I.'s is that in the new plan one of its main aims should be to reduce the great differences in density

Table I

Comparison of Off-Street Parking Standards for Various Building Types Including the Adopted and Recommended Basic Standards for the City of Edmonton, Alberta

		One Off-Street Parking Stall For Each						
Building Types	Recommended Basic Unit	Number of Cities Analyzed by Eno	Modal Values	Range of Middle Two-third Values	Average of 185 American and Canadian Cities	Adopted City of Edmonton Standards	Actual Edmonton Demand Ascertained from 1952 Survey	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Single family residential building	Family unit	94	1 unit	—	1 unit	1 unit	—	Residential areas were not analyzed in the City of Edmonton's Downtown Parking Survey 1952
2-family residential building	Family unit	—	1 unit	—	1 unit	1 unit	—	
Multi-family dwellings	Family unit	176	1 unit	1 unit	1 unit	1 unit	—	
Rooming houses	Guest room (though see remarks)	—	—	—	1 unit	2 spaces per rooming house	—	The incidence of parking demand is considerably less for this use than in a multi-storey apartment building
Theatres and Cinemas	Seat	104	10 seats	5–10 seats	8 seats	10 seats	6 seats	Edmonton's adopted standard less than actual demand
Hotels	Guest room	88	3 guest rooms	2–6 guest rooms	4 guest rooms	10 guest rooms	—	Insufficient data available
Places of public assembly	Seat	93	10 seats	5–10 seats	8 seats	Not fixed	—	Insufficient data available
Retail stores	Sq. ft. gross floor area	56	200 sq. ft.	200–1,000 sq. ft.	500 sq. ft. gross floor area	1,000 sq. ft. net sales space=1,250 sq. ft. gross floor area	430 sq. ft. gross floor area 330 sq. ft.	Up to 20,000 sq. ft. gross floor area

	floor area			sq. ft.	gross floor area	sales space=1,250 sq. ft. gross floor area	gross floor area	floor area
							330 sq. ft. gross floor area	Over 20,000 sq. ft. gross floor area
Office buildings	Sq. ft. gross floor area	49	200 sq. ft.	200–1,000 sq. ft.	500 sq. ft.	1,000 sq. ft. net office space= 1,250 sq. ft. gross floor area	340 sq. ft. net or 450 sq. ft. gross floor area	Present standards nearly one third below demand
Hospitals	Bed	38	4 beds	2–5 beds	4 beds	Not fixed	No data available	
Industrial plants	Number of employees	37	5 employees	2–5 employees	4 employees	Not fixed	Insufficient data available	
Wholesale establishments	Number of employees	16	3 and 5 employees	2–5 employees	4 employees	Not fixed	2½ employees	No standard adopted yet according to known demand
Restaurants	Seat	13	4 and 5 seats	5–10 seats	5 seats	1,000 sq. ft. net eating space	11 seats	Edmonton's adopted standard too low
Bowling alleys	Alley	—	—	—	½ unit	Not fixed	1.5 stalls per alley	Based on one available sample
Bank	Sq. ft. gross floor area	—	—	—	500 sq. ft.	1,000 sq. ft. net banking floor area = 1,250 sq. ft. per gross floor area	570 sq. ft. gross floor area main bank	Allowance made for a 12-minute turnover period
							470 sq. ft. gross floor area branch bank	Allowance made for a 15-minute turnover period
Service stations (not including auto body works)	Unit	—	—	—	4 stalls per station (does not include space alloted to customers' paid parking area		Not available	

of development which existed before and spread them more uniformly over the whole plan, compatible with the economics of the situation.

Studies made in Britain reveal that F.S.I.'s in cities of about 250,000 vary from 4.5 to 0.5 per block with the average block being around 1.5; also, that towns of smaller population have correspondingly lower F.S.I.'s although such decrease or increase in F.S.I.'s is not proportional with the increase or decrease in population.

It is undesirable for the F.S.I.'s of street blocks per use to differ too much between different blocks of similar uses, and between different zones. Such differences if excessive tempt developers to choose sites where the highest F.S.I. prevails and an unbalanced density of over-all development occurs. Something similar to that is found in our existing downtown areas which have definite focal points of over-development derived from the magnetizing action of excessive inflated land values clustered at these points. Also, those blocks in the new plan which front on abnormally wide streets, such as main or arterial roads, should suffer a slightly lower F.S.I. than similar blocks of similar use facing normal width streets, for the same reasons.

The F.S.I. of 1.5 in a shop zone would allow an amount of accommodation in the average block or plot of a three- to a four and one-half-storey building, occupying two-thirds of the block or plot. If parking is planned at grade level outside the building, the one-third of the block or plot left for this purpose may not be enough to satisfy the parking demand calculated from such a development. In this case, either the F.S.I. should be adjusted downwards or the massing of the development take a different form or shape in which more open space is available around the building and a higher building materializes.

Off-street car parking space may be provided around buildings with sufficient set-backs at grade level; in internal courtyards more or less circumscribed by the buildings generating the parking need; underground in basements or sub-basements in multi-storey structures; under open spaces such as downtown civic parks, or squares, etc. But they would merely be parts of an integrated design for the block or area and would in every case be foreseen and integrated

into the general design of the redevelopment plan by the appropriate F.S.I.

Conclusions

In a number of cities and towns, master or development plans for the whole urban area may have been completed before a redevelopment plan for all or part of the central area is considered in detail. This is the right order of working. On the other hand, certain urban areas in which a master plan has not yet been contemplated, started, or completed may suffer in parts of their central areas from pronounced degrees of obsolescence demanding immediate attention. These cities are at some disadvantage if some master plan is unavailable and that is why, in this case in preparing for a redevelopment plan, the survey area should be chosen in excess of the actual part due for redevelopment. This precaution is to make sure that any proposals for the redevelopment area, good as they may be in themselves, do not ultimately backfire on the neighbouring parts of the central area as a whole because they have not been conceived with due regard to inter-relationships.

Attention is specially drawn to the need for full information on traffic conditions and population, because future prosperity of central areas will depend to a considerable extent on the success of the plan in providing for the smooth flow of traffic. The planner should have some idea of the growth of traffic in his area, its origin and destination, main points and times of congestion, street accidents, and the distribution and adequacy of parking facilities. The plan must also take into account the total day-time population of the central area, and the stages by which a redevelopment could be carried out will be greatly influenced by the rate at which persons living or working under unhealthy conditions in the survey area can be removed and obsolete buildings demolished.

In conclusion, it will be appreciated that if the total density of building accommodation per lot, per block, per super-block or per area is indeed controllable, either by the F.S.I. method or by some other method and if minimum and realistic off-street parking standards are selected and enforced, then we possess enough facts to know approximately what the total potential demand would be for off-street parking stalls, according to kind of parking per lot, per

block, per super-block or per area. This demand, interpreted in terms of physical need of land or buildings, becomes in turn an integral part of all calculations required for the design of our total redevelopment, and an integral part of whatever standards of F.S.I. are indicated, and we could not go far wrong. The estimation in detail of correct and applicable F.S.I.'s for cities of different sizes in the United States would provide an excellent subject for a doctoral or master's thesis. Perhaps one will be forthcoming soon.

The Effectiveness of Parking Meters

R. H. BURRAGE

Mr. Burrage joined the Bureau of Public Roads in 1936 and participated in special activities of the highway planning surveys in some twenty states for the next two years. In 1938 and 1939 he was Bureau Manager for Public Roads with the Rhode Island Highway Planning Survey. In 1939 he was recalled to active duty with the U. S. Corps of Engineers, serving until 1946. Since 1946 he has been head of the Terminal Facilities Unit of the Bureau of Public Roads in Washington, and in that capacity has developed the procedural methods for and participated in the comprehensive parking studies which have thus far been made in over one hundred cities throughout the United States. He is a member of the Institute of Traffic Engineers and is registered as an engineer in the District of Columbia.

THE use of parking meters in the control or enforcement of parking regulations has become generally accepted, but for varying reasons. Some persons believe that when well backed by police enforcement, meters greatly reduce overtime parking; many admit that in any case meters promote more orderly use of the curb, and city officials sometimes welcome them as dependable revenue producers. Certainly in many cities their beneficial effects have been greatly weakened because they are treated as money raisers and overtime use by "meter-feeders" is condoned. Indeed, unfortunately many cities have local ordinances which do not even prohibit this practice.

Studies to determine the actual effectiveness of meters have been relatively rare, and in some cases their significance or value has been lessened by the fact that the observations were made by the "cruising" or "interval" type of study, wherein license numbers of parked cars are recorded at intervals of thirty or fifteen minutes by roving observers. While this procedure does detect most if not all of the overtime parkers, it is deficient in that it misses many of the short-time parkers, who play the major part in determining the use of a curb facility.

It may be helpful therefore to appraise the effectiveness of meters in promoting better use of the curb space and time.

Criteria

While the basic objective in using meters is presumably to eliminate or reduce overtime parking, there are several commonly used indices of their effectiveness.

1. Since a part of the objective is to make the curb space available to more users, perhaps the most common point of view is that the one true criterion is an increase in turnover, i.e. in the number of parkers using each space in a given period.

2. Others hold the opinion that the way to eliminate overtime parking necessitates reducing the number or proportion of violators.

3. Some, familiar with the habits of overtime parkers, realize that a few persons may thus use up more time than a large number of minor violators; these stress a decrease in the average parking duration of the violators as the important factor.

4. Expressing the same thought differently, still others consider a decrease in the proportion of overtime (to the total time) most significant.

Since each of these characteristics reflects a desirable objective it is appropriate to examine their interrelationships. This may be done by a series of hypothetical or assumed cases in which one factor or another is varied.

In Table 1, four such cases are presented, each comparing a posted area (unmetered but time-restricted) with a metered area. In each case it is demonstrated that an improvement, in the metered area, in one of the criteria is not necessarily accompanied by improvement in the others and may in fact be offset by poorer performance in one or more of the others.

In case A, although the metered area shows a turnover of 4.2 as against 3.7 in the posted area, it also shows a larger proportion of violators, a larger proportion of time used by them and a larger average parking duration. The better turnover cannot be credited to the presence of meters and presumably was due to a heavier demand at the metered spaces.

In case B, the metered area shows a smaller number and proportion of violators, but a larger proportion of available time used by them, the same turnover, and a higher average duration. The lower proportion of violators actually produced no benefit whatever.

In case C, the metered area shows a lower average parking dura-

Table 1

COMPARISON OF POSTED[1] AND METERED PARKING UNDER VARIOUS ASSUMED CONDITIONS (1-HOUR SPACES)

	A Higher turnover in metered area (10 hours)		B Lower proportion of violators in metered area		C Lower average duration of violators in metered area		D Lower proportion of time used by violators in metered area	
	Posted	Metered	Posted	Metered	Posted	Metered	Posted	Metered
Spaces available—Number	100	100	100	100	100	100	100	100
Space-hours available—Number	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Overtime parkers—Number	70	90	50	40	50	60	50	60
Percent	19	21	11	9	11	13	33	40
Legal parkers—Number	300	330	400	410	400	390	100	90
Percent	81	79	89	91	89	87	67	60
Total parkers—Number	370	420	450	450	450	450	150	150
Space-hours used in overtime	140	270	350	360	450	480	450	420
legally	370	420	450	440	450	450	150	150
total	510	690	800	800	900	930	600	570
Percent used in overtime[2]	27	39	44	45	50	52	75	74
Average hours used by overtime parkers	3	4	8	10	10	9	10	8
Turnover	3.7	4.2	4.5	4.5	4.5	4.5	1.5	1.5

[1] Unmetered but time-restricted.
[2] Percent of total time used.

tion for the violators, but a higher proportion of them more than offsets that gain, and there was no improvement in turnover.

In case D, the metered area shows a lower proportion of available time used by the violators, but a larger proportion of them and no increase in turnover.

Clearly, the presence of only one of these desirable conditions in a metered area does not necessarily signify that the meters have had a net beneficial effect, since it may be accompanied and offset by another undesirable factor. But when all or most of these desirable conditions appear in the metered area under comparison, the presumption is strong that the meters have been instrumental in the improvement.

Procedure in Testing Effectiveness

The criteria in the foregoing paragraphs were applied to two types of data:

1. From data obtained in comprehensive parking studies in 63 cities in 25 states it was possible to make comparisons between the performance at posted (unmetered but time-restricted) spaces and at metered spaces in each of the several time-restricted groups.

2. Before-and-after studies provided data on performance at the same spaces before and after the installation of meters, in two cities.

In the comprehensive parking studies, observation was continuous and the arrival and departure of each vehicle were recorded to the nearest minute, together with a record of the type of space occupied.

Table 2 combines and summarizes the data on posted (unmetered but time-restricted) and metered spaces from the reports of the comprehensive studies in 63 cities. In the aggregate, the data represent the parking performance of 556,160 parkers using 30,523 posted spaces and 38,161 metered spaces. The 63 cities are listed in Table 5. In most of these cities the enforcement of meter regulations was slight and where there was enforcement it was usually confined to tagging only the violators indicated by "red flags."

Group 1 of Table 2 includes 63 cities throughout the country, which were studied and which have either posted spaces or metered spaces, or both, and compares the performance of these two condi-

Table 2

Comparison of Overtime Parking at Posted and Metered Spaces

Zones	Number cities having P spaces	Number cities having M spaces	Total number cities	Percent parking overtime: Posted	Percent parking overtime: Metered	Percent of space hours used in excess: Posted	Percent of space hours used in excess: Metered	Average hours overtime parkers: Posted	Average hours overtime parkers: Metered	Turnover: Posted	Turnover: Metered	Percent difference in turnover
I. For all cities												
15–min.	19	12	24	38.9	39.2	45.0	50.1	1.34	0.82	9.8	20.2	+106
30–min.	21	5	24	31.8	28.9	40.4	44.1	1.78	1.39	9.0	13.2	+ 47
1–hour	42	41	52	24.6	19.2	31.9	25.9	2.73	2.17	6.7	9.9	+ 48
2–hour	28	34	44	20.3	7.5	24.0	11.6	4.14	3.75	4.6	8.1	+ 76
All	54	48	63	25.1	17.1	30.5	22.1	2.77	2.21	6.3	9.5	+ 51
II. Cities having both posted and metered spaces with same time restrictions												
15–min.	5	5	5	55.5	53.8	54.3	56.2	1.62	0.82	6.7	15.9	+137
30–min.	2	2	2	50.1	28.2	68.8	42.3	2.69	1.46	5.0	13.1	+162
1–hour	30	30	30	28.5	19.5	37.8	26.6	3.07	2.17	5.5	9.8	+ 78
2–hour	18	18	18	17.6	10.0	22.0	14.2	4.11	3.79	4.9	6.9	+ 41
All	35	35	35	26.3	19.2	32.9	25.0	3.15	2.16	5.3	9.4	+ 77
III. Cities having only posted spaces or only metered spaces												
15–min.	14	7	21	31.2	25.2	36.7	40.9	1.10	0.80	12.5	27.3	+118
30–min.	19	2	21	30.8	41.0	37.7	50.7	1.70	1.22	9.5	13.8	+ 47
1–hour	12	11	23	22.3	18.2	27.5	23.8	2.49	2.16	7.7	9.9	+ 29
2–hour	10	16	26	24.0	6.1	26.5	9.9	4.17	3.71	4.2	8.8	+110
All	35	23	58	24.3	13.4	28.6	17.3	2.50	2.32	7.1	9.6	+ 35

tions. The first comparison is between the percentage of overtime parkers at posted and metered spaces, and shows no better performance for the metered spaces in the 15-minute zones, a slightly better performance in the 30-minute zones, and increasingly better performance in the one- and two-hour zones.

The percentage of space hours used in excess of legal limits is slightly more for 15- and 30-minute limits at metered spaces than at posted spaces. In the one- and two-hour zones, however, use of overtime is considerably lower at metered spaces. The average duration of overtime parking shows reductions ranging from 9 to 39 percent for metered spaces in all time zones when compared with posted spaces.

Turnover in the use of space shows to considerable advantage at metered spaces in comparison with posted spaces—from one and a half to two times as much.

In the one- and two-hour zones every factor is better in the metered spaces, positive evidence of the benefit brought by meters in these zones.

Data in Group II are from 35 cities wherein each time restriction class is represented by both posted and metered spaces. At first this might appear to permit a more direct and equitable comparison, but it should be remembered that in cities having both posted and metered spaces with the same time restrictions, the metered spaces are closer in and therefore subject to heavier demands than the posted spaces. The result is a larger turnover than that which might otherwise be credited to the meters. It is of interest to note, however, that except in the 15-minute zones, *all* factors are better in the metered zones.

Data for Group III are from 58 cities which in each time restriction zone have only posted spaces or only metered spaces. Since, in these cities, in any zone, neither type of space is likely to be more remote than the other, this comparison is the most reasonable possible, other than by before-and-after studies.

The metered spaces in this group show markedly better performance in the percentage parking overtime in three of the four zones, in the proportion of time used by violators in two of the four, in average duration by violators in all zones, and in turnover in all zones. For Group III as a whole, the metered spaces were 45 percent lower in percent of overtime parkers, 39 percent lower in proportion

of overtime used, 7 percent lower in average duration of violators, and 35 percent higher in turnover. The benefits in the 15- and 30-minute zones are not conclusive, but there can be no question as to the one- and two-hour zones, which include 96 percent of all metered spaces.

Of collateral interest in the basic data are the maximum turnovers found as follows:

Zones	City	Type	Number Spaces	Period	Turnover
15–min.	Roswell, N. Mexico	Metered	7	10 hours	64.9
30–min.	Butler, Pa.	Posted	11	10 hours	25.8
1–hour	Coatesville, Pa.	Metered	141	10 hours	17.2
2–hour	Anderson, S. C.	Metered	386	10 hours	15.8

Data are available from before-and-after studies of meter effectiveness in two cities, using a continuous observation procedure.

In the District of Columbia, in January and May, 1949, 64 one-hour spaces at three locations were studied, shortly *before* the installation of meters and again about three months *after* the installation. The results were as follows:

Table 3

PARKING METER EFFECTIVENESS STUDY, WASHINGTON, D. C.

	Before	After
Number curb spaces	64	64
Space hours available	435.2	424.5
1 hour or less, number parkers	96	407
Percent (of all parkers)	48.9	80.3
Space hours used	38.7	180.8
Percent (of available hours)	8.9	42.6
Average time	25 min.	26.5 min.
Overtime parkers, number	100	100
Percent (of all parkers)	51.1	19.7
Space hours used	382	194
Percent (of available hours)	88.2	45.7
Average time	3 hrs. 49 min.	1 hr. 56 min.
Percent time used illegally	65	22
All parkers, number	196	507
Space hours used	420.7	374.9
Percent (of available hours)	97.1	88.4
Average time	2 hrs. 9 min.	44.5 min.
Turnover	3.1	7.9

This test showed a marked improvement in all important criteria, following the installation of meters.

In Reno, Nevada, four selected curb faces were studied, first as 1-hour posted spaces in 1948 and then as 1-hour metered spaces in 1949; the observations were for three days in each case, for twelve hours per day.

Table 4

PARKING METER EFFECTIVENESSS STUDY, RENO, NEVADA

	Before	After
Number spaces (4 faces)	61	61
Number overtime parkers (3 days)	416	550
Percent	25.3	29.6
Minutes of overtime used (3 days)	24,423	20,449
Average	58.8	37.2
Percent of total time used as overtime	27.8	23.3
Total parkers (3 days)	1,643	1,859
Turnover (per 12-hour day)	8.97	10.17
Number double parkers (3 days)	100	208
Minutes used by double parkers	2,760	1,685
Average time, minutes	27.6	8.3

In Reno the installation of meters definitely improved conditions, although not to so great an extent as in some other cities. The number and proportion of overtime parkers increased, but the total overtime fell off 16.3 percent, the average overtime fell 36.7 percent, and the turnover increased 13.4 percent. That the improvement was less marked than in other cities may largely be attributed to the fact that at the time of the study, there was no enforcement against meter-feeding, and indeed paid overtime parking was not prohibited by local ordinance.

It also is interesting to note that the Reno report showed that in the area studied, after the installation of meters, the worker-parkers decreased 54 percent, while the business-parkers increased 57 percent, the shopper-parkers 19 percent and the recreation-parkers (important in Reno) 113 percent.

Table 5

The foregoing data were summarized from studies in the following cities:

City	1950 urban population	City	1950 urban population
Albuquerque, N. Mex.	96,815	Lexington, Ky.	55,534
Alexandria, La.	34,685	Lincoln, Nebr.	98,048
Allentown, Pa.	225,155	Louisville, Ky.	470,394
Anderson, Ind.	46,809	Lynchburg, Va.	47,639
Anderson, S. C.	19,718	Martinsville, Va.	17,210
Baltimore, Md.	1,151,052	Meadville, Pa.	18,906
Bethlehem, Pa.	225,155	Memphis, Tenn.	404,033
Biddeford, Saco, Me.	31,134	Monroe, La.	38,375
Boise, Idaho	34,152	New Haven, Conn.	242,589
Bristol, Va.–Tenn.	32,618	Norristown, Pa.	38,193
Butler, Pa.	23,511	North Bethlehem, Pa.	225,155
Charlotte, N. C.	140,085	Ogden, Utah	57,112
Chattanooga, Tenn.	167,031	Omaha, Nebr.	306,291
Cleveland, Ohio	1,372,274	Pawtucket, R. I.	81,180
Clovis, N. Mex.	17,168	Portland, Ore.	509,120
Coatesville, Pa.	13,839	Pottstown, Pa.	22,616
Columbus, Ind.	18,305	Providence, R. I.	581,607
Corpus Christi, Tex.	122,354	Reading, Pa.	154,571
Dallas, Tex.	536,864	Reno, Nev.	32,225
Decatur, Ind.	7,272	Richmond, Va.	257,423
Easton, Pa.	34,410	Roswell, N. Mex.	25,572
Eugene, Ore.	35,672	Seymour, Ind.	9,635
Evansville, Ind.	133,200	Spokane, Wash.	174,853
Fond du Lac, Wis.	29,826	St. Louis, Mo.	1,394,051
Frankfort, Ind.	14,933	Stevens Point, Wis.	16,550
Gary, Ind.	133,911	Toledo, Ohio	361,493
Harrisburg, Pa.	168,933	Topeka, Kans.	88,100
Honolulu, T. H.	248,034	Uniontown, Pa.	20,423
Huntington, Ind.	15,033	Wabash, Ind.	10,594
Knoxville, Tenn.	148,174	West Chester, Pa.	15,109
Kokomo, Ind.	38,600	Wichita, Kans.	192,009
Lake Charles, La.	41,202		

	Posted spaces		Metered spaces		All spaces[1]		Number parkers at		
Zones	Number	Percent	Number	Percent	Number	Percent	Posted spaces	Metered spaces	All spaces
15–min.	1,238	4.0	556	1.5	1,794	2.6	12,119	11,211	23,330
30–min.	1,659	5.4	876	2.3	2,535	3.7	15,029	11,569	26,598
1–hour	18,018	59.1	25,199	66.0	43,217	62.9	121,253	248,427	369,680
2–hours	9,608	31.5	11,530	30.2	21,138	30.8	44,180	92,372	136,552
All	30,523	100.0	38,161	100.0	68,684	100.0	192,581	363,579	556,160

[1] Exclusive of unrestricted spaces.

Conclusions

1. The effectiveness of parking meters (as compared to unmetered time-restrictions) should be judged by considering several factors:

   a. The proportion of overtime parkers.
   b. The proportion of overtime used by them.
   c. The average parking duration of these violators.
   d. The turnover (the number of parkers using each space in a given period).

2. An improvement found in a metered area in any one of these factors may be due to the effect of the meters, but may not constitute or signify any net improvement in conditions unless accompanied by improvement in several other or all of the other conditions. An improvement in all of these criteria is reasonably conclusive evidence of the effectiveness of the meters.

3. In 15- and 30-minute zones, meters are not markedly effective unless strongly enforced. While the desirability of enforcement in all zones is obvious, meters have a definitely beneficial effect in one- and two-hour zones, whether enforced or not, and these zones include 96 percent of all metered zones.

Virginia's Largest Highway Project

J. P. MILLS, JR.

Mr. Mills started work with the Planning Survey of the Virginia Department of Highways in June, 1936. He was promoted to Traffic and Planning Engineer on October 1, 1952. He is a member of the Institute of Traffic Engineers and the American Association of State Highway Officials.

HAMPTON ROADS, one of the finest seaports in the world, is also a water barrier that has long impeded motor vehicle travel. Only a few miles—five between Norfolk and Newport News, and two and one-half from Norfolk to Old Point Comfort—separate two of Virginia's largest metropolitan areas. The area to the south centered around Norfolk had a population of 446,200 in 1950. The area on the north side, including Newport News, Hampton and Warwick, had a population of 143,227 in the same year.

Here were 589, 427 people living only a few miles apart, yet strangers because of the water barrier. On the average day in 1953, only 3,719 vehicles used the ferries in moving to and from the two areas.

On both sides of Hampton Roads we have numerous Army, Navy and Air Force Bases. The area is served by excellent highways but Hampton Roads presents a motor-travel barrier that could only be broken by a tunnel or bridge. The 1950 Virginia legislature fully realized the inadequacy of ferry transport to cope with today's travel. The legislature directed the highway commission, through the Revenue Bond Act, to construct a bridge-tunnel across Hampton Roads to replace the ferries, provided the project were feasible and, coupled with the other projects, show a revenue-cost-ratio of at least 1.6.

The other projects referred to are:

1. The James River Bridge System
2. The Yorktown Bridge
3. The Rappahannock River Bridge

Tunnel Idea Conceived in 1920

Thus 1950 brought nearer a dream that started in 1920—thirty years before. It was in that year that Captain W. R. Boutwell envisioned a railroad tunnel under Hampton Roads connecting the north and south sides of this heavily populated area. Major Maury Boykin, a teacher and engineer, became interested in Captain Boutwell's plan and spent many an hour on study and research. Major Boykin came up with a plan for a causeway-tunnel project between Norfolk (Willoughby Spit) and Old Point Comfort. A great deal of interest was aroused, various organizations studied the scheme and many people were favorable toward such an idea. However, back in those days no one wanted to take the initiative because of the tremendous cost involved.

When Captain Boutwell and Major Boykin were studying a tunnel connection, the motor vehicle was in its infancy. The emphasis was on moving freight and commodities by rail. The tremendous surge of travel by motor vehicle changed the complexion of the Hampton Roads Crossing. Although the depression days of 1929 and the early 30's curtailed nearly everything else, motor vehicle travel continued upward. The importance of the motor vehicle was recognized by reviving the proposed tunnel. Only this time, it was planned for motor travel rather than rail.

Interested parties in the Hampton Roads area engaged a New York firm to review Major Boykin's plan and to see what could be done toward changing this plan into a vehicle tube rather than a railroad tunnel. The consultants found that by increasing the diameter of the tube from 23′ 4″ to 29′ it could be changed from a railroad tunnel into a vehicle tube suitable for use by passenger cars and commercial vehicles in crossing Hampton Roads.

The results of the consultants' study in 1936 looked inviting and considerable interest was aroused on both sides of Hampton Roads. Mayor Boykin, retained to work out a scheme of financing, estimated a tunnel and trestle approach at $8,000,000. This was in the days of the depression. Labor was cheap and federal help was available. Considerable interest was shown but no one wanted to or knew how to finance such a costly project. So it languished again for many years.

The late 40's saw the tunnel idea revived again by a group from

the north side of Hampton Roads. This group (the Lower Penisular Planning Commission) realized the potential value of a tunnel and engaged consultants to study the project. They reported that a tunnel was feasible and could be built for approximately $23,000,000. Considerable interest was aroused in all communities involved and resulted in the action taken by the 1950 legislature.

Consultants' Study for Highway Department

In 1950, the highway department retained consulting engineers to study the tunnel possibilities. It is interesting that for the first time, consultants had detailed origin and destination information to work with. Prior to this time, it had been taken for granted that the only possible location was from Willoughby Spit to Old Point Comfort.

The consultants studied six locations, as shown in Figure 1. Line 3–B was recommended as the location nearest and serving best the mean desire line of traffic. The consultants made the following recommendation: that the highway department file with the Department of Army, applications to construct; initiate the necessary enabling legislation; contract for preliminary borings, and authorize preparation of final engineering and revenue feasibility reports.

In July, 1951, an application was made to the Department of Army for a permit to cross Hampton Roads along Line 3–B. Line 3–B was most objectionable to both the Navy and Army. The southern approach was in the Norfolk Naval Base. The application for a crossing was returned with the request that the department give further study to a crossing which would:

(a) keep approaches off of military installations,

(b) not interfere with anchorage area in Hampton Roads, and that

(c) no bridge would be permitted over shipping channels.

In a second report released in July, 1952, the consultants quickly realized that the only acceptable route to the Army and Navy would be from Willoughby Spit (Norfolk) to some point near Old Point Comfort (Hampton). Line 6 (Line 1 revised slightly) was selected after a long and careful study.

Although they classified it as a preliminary report, the consul-

tants carefully analyzed detailed traffic studies made by the traffic and planning division of the highway department and reported that Route 6 was feasible and that the tunnel could be constructed.

For the next several months, highway engineers spent many hours with interested parties on both sides of Hampton Roads in an effort to pin down a location acceptable to the majority and satis-

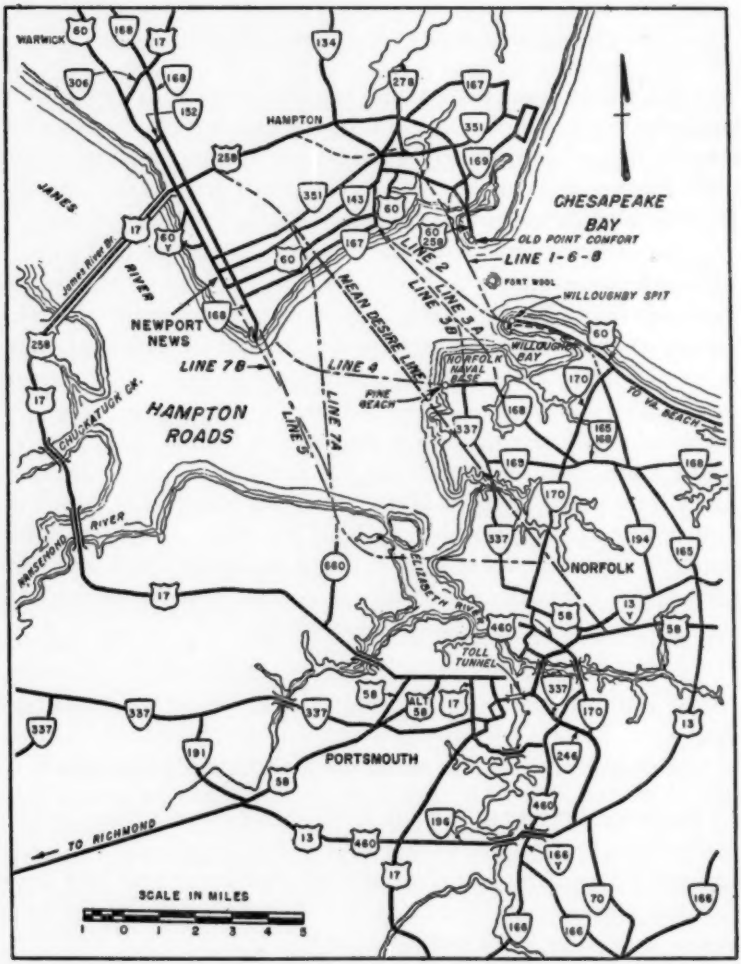


FIGURE 1. Hampton Roads and Immediate Area to the North and South.

factory to the engineers. The only opposition was that from local citizens—usually found in projects such as this. Although more than 99 percent of the people of the two areas wanted the tunnel connection, a number of persons opposed a location which would mean the acquisition of their homes or businesses.

In the latter part of 1953, the highway department decided to build the tunnel project and retained an engineering firm plus traffic consultants to make a joint traffic and earnings report.

The traffic consultants report that the tunnel is an excellent project; that together with the other projects of the Revenue Bond Act, the bonds can be retired in forty years at a coverage of 1.81 times debt service. This is based on a total bond issue of $100,000,000 and an interest rate of 3 percent. Of this, $58,500,000 would be for the construction of the tunnel and approaches. The remainder would be for buying up present revenue bonds (Ferry, James River Bridge and Yorktown Bridge), the construction of the Rappahannock River Bridge and for interest and other charges.

Facts on Proposed Project

Tunnel and Approach Roads

Length—23 Miles
Estimated Cost—$58,500,000

Tunnel Only

Length—7,479 feet
Roadway Width—23 feet
Vertical Clearance—14 feet, 2 inches
Roadway—100 feet below sea level
Top of tunnel averages 60 feet below water
Portal islands as large as Fort Wool

Approach Roads

24–foot concrete from Route 17 to Route 258
48–foot concrete from Route 258 to Sewells Point Road with variable divider strip separating opposing traffic in two 24–foot roadways
Approach trestles 30 feet wide

Traffic Studies

Since 1949, a great deal of information has been collected in an all-out effort to obtain a tunnel crossing in the best location and one which could be justified. Nearly all of the field work was conducted and analyzed by the highway department. These field studies and the results obtained are described below:

A. *Traffic Counts*

1. Detailed traffic information on the operation of both ferries for a number of years.
2. Same information for the James River Bridge.
3. Manual classification counts on all primary roads in the area. This information was available on all roads back to 1938 and on a few to 1927.

B. *Origin and Destination Studies*

1. Ferry Traffic: All motorists using both ferry crossings for a number of days were questioned as to origin and destination, number of trips and other information generally obtained on such a survey.

   A number of pedestrians ride the two ferries. They were questioned to get some idea of bus service for the tunnel.
2. James River Bridge Traffic: Same information obtained as in (1).
3. *Divertible Traffic:* Only two sources of traffic could possibly be diverted to the tunnel outside of the ferry traffic: one was the James River Bridge traffic, the other was traffic from Richmond to the Norfolk area now using Routes 460 or 10.

   Interview stations were located on both Routes 460 and 10. Information collected at these stations was similar to that obtained at the ferries and on the James River Bridge.

C. *Driving Delay Studies*

Because detailed time studies would be needed in allocating traffic, a number of drives were made over existing routes and

extreme care was taken to insure results that would represent average conditions.

Before undertaking the analysis of the information collected, the area to the north of Hampton Roads was divided into nineteen zones and to the south of Hampton Roads in thirteen zones.

It is important to note that local traffic now has two choices in traveling between the Norfolk area and the area to the north of Hampton Roads: by the ferries, and by the James River Bridge. Traffic from the Richmond area to the Norfolk area can travel via the same ferries and James River Bridge or via Petersburg and Routes 10 or 460.

It was the opinion of our consultants that motorists will continue to place the same value on time and distance as they do at present when deciding which route to use. With this in mind, a curve was plotted based on the information obtained from our study and traffic allocated accordingly.

Mean Desire Line of Ferry Traffic

Prior to the engineers' report in 1951, it had been taken for granted any crossing would be in the vicinity of Line 1. The consultants, in their 1951 report, recommended Line 3–B since that line would come nearer serving traffic than any other line. The mean desire line is shown in Figure 1.

The same consultants in 1952 (their second preliminary report) recommended Line 6, a slight deviation of Line 1, the original line recommended as a railroad tunnel in 1920.

In the years to come, the mean desire line of traffic crossing Hampton Roads is bound to shift eastwardly. Reasons for this shift are:

a. Norfolk is expanding rapidly eastward and cannot expand to the west because of the Elizabeth River.

b. Virginia Beach and Princess Anne County are both increasing in importance and their population has increased 140 percent in the last ten years.

c. Because the James River is a natural barrier on the west, the

Table I

Comparison of Driving Times and Distances Between Several Intersections on Each Side of Hampton Roads By the James River Bridge, Ferries, and the Proposed Hampton Roads Bridge–Tunnel Crossing

From or To	From or To	Travel Time By			Travel Distance By		
		Nearest Ferry (Min.)	James River Bridge (Min.)	Proposed Tunnel (Min.)	Nearest Ferry (Miles)	James River Bridge (Miles)	Proposed Tunnel (Miles)
(1) Route 60 & Route 258	(8) Naval Operating Base	54	67	35	9.6	35.7	22.2
"	(9) Cottage Toll Road & Granby Street	70	65	29	16.3	35.3	17.5
"	(10) Olney & Church Streets	75	48	45	17.3	28.1	25.2
"	(11) 38th Street & Hampton Boulevard	65	58	41	14.4	31.4	24.6
"	(12) Route 58 at E.C.L. Norfolk	70	51	45	18.8	30.0	28.2
"	(13) Wilson Road & Berkley Avenue (Berkley)	83	49	52	19.9	28.3	30.8
"	(14) High Street & Air Line Boulevard	91	32	61	22.1	23.3	30.0
(2) 25th & Jefferson Avenue	(8) Naval Operating Base	47	75	39	6.2	39.2	21.2
"	(9) Cottage Toll Road & Granby Street	62	73	33	12.9	38.8	16.6
"	(10) Olney & Church Streets	67	56	48	13.9	31.6	23.3
"	(11) 38th Street & Hampton Boulevard	58	65	45	11.0	34.9	22.7
"	(12) Route 58 at E.C.L. Norfolk	73	59	49	15.4	33.5	26.3
"	(13) Wilson Road & Berkley Avenue (Berkley)	75	56	56	16.5	31.8	28.9
"	(14) High Street & Air Line Boulevard	83	39	64	18.7	26.8	28.1
(3) 25th & Wickham Avenue	(8) Naval Operating Base	48	76	37	6.7	39.7	20.7
"	(9) Cottage Toll Road & Granby Street	63	74	31	13.4	39.3	15.1
"	(10) Olney & Church Streets	69	58	47	14.4	32.1	22.8
"	(11) 38th Street & Hampton Boulevard	59	67	43	11.5	35.4	22.4
"	(12) Route 58 at E.C.L. Norfolk	74	60	47	15.9	34.0	25.8
"	(13) Wilson Road & Berkley Avenue (Berkley)	77	58	55	17.0	32.3	28.4
"	(14) High Street & Air Line Boulevard	85	41	63	19.2	27.3	27.6

From or To	From or To	Travel Time By			Travel Distance By		
		Nearest Ferry (Min.)	James River Bridge (Min.)	Proposed Tunnel (Min.)	Nearest Ferry (Miles)	James River Bridge (Miles)	Proposed Tunnel (Miles)
(4) 25th & Catalpa Avenue	(8) Naval Operating Base	53	80	37	8.4	41.5	19.2
"	(9) Cottage Toll Road & Granby Street	68	78	29	15.1	41.1	13.6
"	(10) Olney & Church Streets	74	62	45	16.1	33.9	21.3
"	(11) 38th Street & Hampton Boulevard	64	71	41	13.2	37.2	20.7
"	(12) Route 58 at E.C.L. Norfolk	79	64	45	16.6	35.6	24.3
"	(13) Wilson Road & Berkley Avenue (Berkley)	82	62	52	18.7	34.1	26.9
"	(14) High Street & Air Line Boulevard	90	45	61	20.9	29.1	26.1
(5) La Salle & Victoria Blvd.	(8) Naval Operating Base	59	79	32	10.8	43.1	17.2
"	(9) Cottage Toll Road & Granby Street	72	77	24	10.4	42.7	11.6
"	(10) Olney & Church Streets	80	61	40	18.5	35.5	19.3
"	(11) 38th Street & Hampton Boulevard	70	70	36	15.6	38.8	18.7
"	(12) Route 58 at E.C.L. Norfolk	85	63	40	20.0	37.4	22.3
"	(13) Wilson Road & Berkley Avenue (Berkley)	88	61	47	21.1	35.7	24.9
"	(14) High Street & Air Line Boulevard	96	44	56	23.3	30.7	24.1
(6) West Queen & King Streets	(8) Naval Operating Base	64	78	27	12.8	43.1	14.9
"	(9) Cottage Toll Road & Granby Street	67	76	21	7.4	42.7	9.3
"	(10) Olney & Church Streets	85	59	37	20.5	35.5	17.0
"	(11) 38th Street & Hampton Boulevard	75	69	33	17.6	38.8	16.4
"	(12) Route 58 at E.C.L. Norfolk	86	62	37	18.1	37.4	20.0
"	(13) Wilson Road & Berkley Avenue (Berkley)	93	60	45	23.1	35.7	22.6
"	(14) High Street & Air Line Boulevard	101	54	53	25.3	30.7	21.8
(7) Route 60 & Mallory Street	(8) Naval Operating Base	69	83	23	14.9	44.9	13.9
"	(9) Cottage Toll Road & Granby Street	62	80	18	6.3	44.5	8.3
"	(10) Olney & Church Streets	82	64	33	14.0	37.3	16.0
"	(11) 38th Street & Hampton Boulevard	78	73	29	13.4	40.6	15.4
"	(12) Route 58 at E.C.L. Norfolk	82	67	34	17.0	39.2	19.0
"	(13) Wilson Road & Berkley Avenue (Berkley)	89	65	41	19.6	37.5	21.6
"	(14) High Street & Air Line Boulevard	98	47	49	18.8	32.5	20.8

expansion on the north side of Hampton Roads is to the east and north.

d. The completion of a new bridge over the Rappahannock River, plus the new bridge at Yorktown, will provide a direct route from eastern Virginia to Norfolk via the proposed tunnel.

Actual drives were made for traffic now using either the ferries or the James River Bridge. It was necessary to assume speeds on the tunnel and approaches in order to make direct comparisons. Speeds of 35 MPH and 45 MPH were used, respectively. Actual drives were made from the centers of the various zones to the proposed approaches. A few of the comparisons are shown in Table I.

Allocation of Traffic

Thus, with the origin and destination data and time, distance and cost curve, it was a simple matter to allocate traffic. Ferry service is to be discontinued when the tunnel is opened.

A. *Divertible Traffic*

(1) From ferries: All 3,757 vehicles now using both ferries daily would use the proposed tunnel.

(2) 359 vehicles now using the James River Bridge daily would be diverted to the tunnel.

(3) In our analysis of traffic using the free route from Richmond to the Norfolk-Virginia Beach area, it was found that 1,614 trips were made daily. After a careful study, it was decided that the additional benefits of the tunnel route would attract 293 of these 1,614 vehicles.

B. *Generated Traffic*

When a new facility, such as the proposed tunnel, is put in operation, experience shows that many more vehicles use the facility than are accounted for by divertible traffic. This additional traffic— termed "generative," "induced," or "creative" traffic— is very important and in most cases very difficult for consultants to estimate. A number of factors must be considered; for example, population served, mountain or water barriers, attractions available, toll rates, and type of facility offered.

Consultants as a general rule are very accurate in their estimates of divertible traffic. On the other hand they are most conservative in their estimate of induced or creative traffic. Thus this type of traffic acts as a safety valve to the project.

Our consultants estimated that the induced traffic for the tunnel project would amount to 25 percent of the diverted traffic or 1,102 vehicles per day. This estimate appears to be most conservative and seems to provide an excellent safety factor.

Based largely on the experience of water crossings in other states where the increases have ranged from 75 percent to 300 percent, reference is made to the Delaware Memorial Bridge in Wilmington, Delaware, the Lower Tampa Bay Bridge in St. Petersburg, Florida, and the Chesapeake Bay Bridge near Annapolis, Maryland.

Our experience in Virginia is somewhat limited, but two cases are somewhat similar in that:

(1) Yorktown—a toll bridge replaced a toll ferry, and
(2) Norfolk-Portsmouth—a combination bridge and toll tunnel replaced a toll ferry.

The Yorktown Bridge is in a rural area on Route 17 over the York River which separates historic Yorktown from Gloucester County. The bridge replaced a ferry which was providing good service and the distance across this river was only about three-fourths of a mile. At the end of the first year's operation of the bridge, it was found that the induced traffic amounted to approximately 60 percent of the divertible traffic.

The Norfolk-Portsmouth bridge-tunnel combination provides a direct connection between two large Virginia cities. When constructed, it was known that the principal ferry line would still operate and that in addition, the bridge-tunnel would have a competing toll bridge and a free bridge. The ferry provides a fast schedule and is more direct than the bridge-tunnel route. The other toll bridge provides a longer route and passes through a congested area. The free route is several miles longer.

The consultants estimated that the induced traffic for this facility would be 10 percent of the divertible traffic. Actually after a year's operation the induced traffic amounted to between 20 percent and 25 percent of the divertible traffic.

C. *Total Traffic*

Our consultants estimated that if the tunnel had been in operation in 1954, it would have carried an average of 5,511 vehicles per day.

The major contract for the water crossing was let in October and construction is well underway. It is hoped that the project will be completed and in operation in late 1957.

Safety in Pupil Transportation

EARL D. HEATH

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As long ago as 1840 pupil transportation service is reported to have begun in a Massachusetts school district, but it was not until 1869 that this same state enacted the nation's first school transportation law. By 1920, pupils were being transported in all states of the nation, despite the fact that in certain cases specific legal sanction had not been granted.[1]

During this period, and since, the increase in the numbers of pupils transported has been impressive. Perhaps the greatest single factor contributing to this increase has been, and continues to be, the efforts of educators to provide our youth with finer physical facilities and an enriched curriculum. Moreover, better equipment and extensive road improvements have hastened the disappearance of the one-room schoolhouse from the American scene; at the present time, an estimated seventy-five thousand remain, and these are departing at the rate of eight or nine each day.[2]

Unquestionably, highway transportation has been one of the greatest factors in expanding educational opportunity. Where finer schools could not be brought to the pupil, the pupil has been taken to the school. Safe and efficient highway transport has facilitated the consolidation of schools.

While the advent of pupil transportation facilities has introduced millions of children to the finer educational facilities which

[1] National Education Association, Research Division, *Safety in Pupil Transportation*. Washington, D. C.: the Association, 1936. p. 201.

[2] National Highway Users Conference, *The Highway Transportation Story*. Washington, D. C.: the Conference, n.d. p. 11.

replaced out-dated ones, it also has subjected them to the hazards of highways and traffic situations. The more than seven and one-quarter million pupils who daily ride to and from school have no real alternative, since in most instances the neighborhood schools they otherwise would have attended no longer exist. For this reason especially, educators and all others sharing in this important task bear a huge moral responsibility to provide the safest transportation services possible. With more than 135,000 school buses operating on our streets and highways, this means of travel needs more attention than it now receives.

Although the accident injury and fatality rates of school buses are rather favorable when compared to those of other carriers, there is cause not for complacency, but rather for more determined efforts to shrink these rates still further. It is important, therefore, to review certain salient features which make for pupil transportation operations characterized by safety, efficiency, and economy.

Essential Equipment Standards

National standards have been established for the types of equipment used in transporting pupils.[8] These standards have been adopted and extended by the various states to provide specific features deemed essential or desirable for passenger safety and comfort. Manufacturers, of course, must base their construction and design largely upon these recommendations. But while most manufacturers of truck chassis also build school buses, not all of them produce school bus "lines" which meet or exceed the recommended national standards.

As a consequence, it is highly important to check all public and private equipment thoroughly to make certain it equals the established standards. At the very least, a school district should purchase (or contract for the services of) only equipment which meets or surpasses the minimum standards established by, or reported out of, the proper state department of education or other authorized state agency. Preferably, these standards also should be compatible with those of recognized national agencies.

[8] National Commission on Safety Education, National Education Association. *Minimum Standards for School Buses.* (Revised edition). Washington, D. C.: the Commission, 1954.

Each state department of education should make available a set of specifications to the local school district or to the individual contractor. Furthermore, the appropriate state agency should publicize the fact that inadequate equipment will not be permitted to operate within the state. Specifications should be thorough and should cover not only the chassis and body proper, but specialized markings and equipment as well. Consideration should be given to such items as: color of the bus; size, amount and placement of the lettering on the bus; location of the emergency door; location and operation of the emergency door release apparatus; size of the windows; the number and location of "knock-out" windows; the number, type, location and contents of first aid kits; the type, capacity and location of fire extinguishing equipment; the location of the battery; the location of the gasoline tank, and the location and specifications of circuits for the special lights and other devices required on school buses in certain states.

Preventive Maintenance and Inspection

Preventive maintenance involves making minor repairs and adjustments which might develop into major difficulties if left unattended, thereby necessitating extensive and expensive repairs. The foremost objective of a preventive maintenance program is keeping the vehicle in *safe* operating condition. Preventing road failures, maintaining the vehicle in efficient operating condition, lowering maintenance costs by reducing the need for major repairs or overhaul, and preserving the life of all components of the vehicle, though important objectives, are really secondary.

In addition to being the heart of an effective preventive maintenance program, inspection also is one of the greatest safety factors in pupil transportation operation. Too often it has meant nothing more than a formal canvass of the vehicle's interior and exterior features. Actually, each driver should be his vehicle's severest critic, for no one knows more about it than he does. Other individuals can help assure that the vehicle will remain in top operating condition —school bus patrol members, members of the faculty and administrative staff, the supervisor or director of pupil transportation, the owner of the equipment, and the shop foreman. Although they may

seem minor, reports of cracked or broken windows, loose or torn seats, are quite necessary to effective preventive maintenance.

Unfortunately, many pupil transportation operations do not capitalize on the reports of such persons. Accordingly, the legislatures of several states provide for regular inspections. But unless these inspections are frequent, well timed, and conducted at proper locations by adequate and competent individuals, safety cannot be guaranteed. In many cases, states not requiring periodic passenger car inspections insist upon regularly scheduled school bus examinations.

For example, Maryland conducts three inspections a year; Figure 1 shows its inspection report. The report, completed in triplicate, is used for all three of the inspections each year and lends itself for rapid analysis. One copy is retained by the Department of Motor Vehicles, a second by the county's board of education, and the third, if one or more defects are identified, is given to the owner or the person responsible for the vehicle. He retains the copy until the defect(s) have been corrected (a time limit is established). Then he returns the report, signed, to the board of education. The board is responsible for determining whether the defects have been corrected. Once this has been accomplished, the board forwards a confirmation to the Department of Motor Vehicles.

States which do have periodic motor vehicle inspections arrange to have the buses taken to authorized inspection stations at specified intervals; in other instances teams of qualified, authorized personnel travel throughout the state to inspect the equipment at or near its point of operation.

Whatever system is used, though, it is essential that adequate maintenance facilities be available and that they be used effectively. In larger operations, central garages can do the job (as in the State of Virginia). But in smaller districts, a contractual agreement should be worked out with one or more reputable service organizations. In either instance, however, the most important consideration is whether or not the facilities are adequate, both in terms of physical features and competent personnel.

Another preventive maintenance technique exists—that of providing an adequate replacement schedule. Obviously a driver affects the condition of his equipment more than age, *per se*, but there is

DEPARTMENT OF MOTOR VEHICLES

SCHOOL BUS INSPECTION

OWNER CONTRACTED BY

ADDRESS S.B. TAG # S.B.C. #

CHAUFFEUR CHAUFFEUR NO.

1	2	3			3	2	1
			WHEEL BEARINGS	PAINT			
			KING PINS, BUSHINGS	UPHOLSTERY			
			TIE RODS-DRAG LINK	SEAT FRAMES			
			FRONT TIRES	WINDOW GLASS			
			HEAD LIGHTS	FLARES			
			TURN SIGNALS	FIRE EXTINGUISHER			
			WARNING LIGHTS (FRONT)	HAND AXE			
			CLEARANCE LIGHTS	FIRST AID KIT (S)			
			FRONT LETTERING	CLEANLINESS			
			REAR DOOR & DEVICE	FRONT DOOR			
			REAR LETTERING	INTERIOR MIRROR			
			TAIL LIGHT	EXTERIOR MIRROR			
			STOP LIGHT	WINDSHIELD WIPERS			
			WARNING LIGHTS (REAR)	DEFROSTER			
			TURN SIGNALS	HEATER			
			CLEARANCE LIGHTS	HORN			
			REAR TIRES	SERVICE BRAKE			
			EXHAUST SYSTEM	HAND BRAKE			
			SPRINGS	WINDSHIELD GLASS			

INSPECTED BY: DATE

1.
2.
3.

REPAIRS COMP. BY DATE

1.
2.
3.

REMARKS: 1.

2.

3.

ORIGINAL TO BE SENT TO DEPT. OF MOTOR VEHICLES.

DUPLICATE TO BE RETAINED BY SCHOOL BOARD.

DEFECTS TO BE CORRECTED AND YELLOW COPY TO BE RETURNED TO THE SCHOOL BOARD WITHIN 10 DAYS.

Courtesy: Department of Motor Vehicles, State of Maryland

FIGURE 1. School bus inspection report in use in the State of Maryland.

little likelihood that a fleet of comparatively new vehicles, properly maintained, will be afflicted with mechanical malfunctions. Many states recognize this fact by amortizing equipment over relatively short periods of time.

Establishing Transportation Areas

Few people agree on just what constitutes a transportation area. This situation is largely due to the fact that a "reasonable walking distance" is an arguable point. Further complications arise when services are provided only for certain age and grade levels within a specified area. In most cases the areas from which students will be transported depends largely on the opinions of school officials and on the financial resources of the individual school administrative unit.

Increasingly, school districts are being asked to provide transportation in areas where the walking distances are not unreasonable but where certain hazards exist. The school bus has been and is being) used to reduce pupil exposure to certain hazardous situations; in other words, it is easier to make these demands than to correct the conditions which provoke them. A considerable saving in public monies could be effected if additional sidewalks and adequate shoulders were provided; often the school is asked to furnish transportation services in areas where such services are neither desirable nor necessary.

Generally, travel routes are established by identifying road distances from the school beyond which pupils should be provided with transportation services. Therefore, a thorough survey of the area included in a particular school system should be conducted to determine which areas warrant bus service. Special provisions should be made for handicapped pupils and for those residing in the vicinity of thoroughfares that afford the pedestrian relatively little protection. In recent years, many schools in metropolitan areas having commercial transit facilities use these facilities in lieu of the conventional school bus. Such a trend seems to lessen traffic congestion and probably reduces budgetary expenditures.

Effective routing can be a major factor in compensating for certain shortcomings in current traffic laws and ordinances. It is an

aid to the pupil, the bus driver and the motorist. A compilation of *State Laws on Passing School Buses Stopped to Load or Unload Pupils,* prepared and distributed by the school transportation committee of the National Safety Council, revealed four different procedures in effect in forty-seven of the states.

Establishing Satisfactory Routes

In establishing routes to serve pupils in a particular area adequately, it has been found advisable first to procure a map of the area served by a particular school or school district. On such a map information on road conditions, railroad crossings and other factors which might affect the particular operation is recorded along with locations of homes and the number of school-age children at each. The area then is surveyed personally, and satisfactory school bus stops are identified in accordance with students' location, and along streets and highways where buses can travel with the least amount of danger. The number of pupils to be transported and the distances to be traveled are primary factors in allocating equipment for a particular area. Then students are assigned to specific stops according to the distances it would be necessary for them to walk, according to grade level, and according to the school attended.

Circuitous routes frequently result in greater efficiency than so-called straight line routes because back-tracking is eliminated, coverage is increased, and time consumed in actual transportation generally is reduced. Moreover, such circuitous routes usually require the equipment to travel fewer miles without passengers, thereby reducing costs. Re-tracing routes should be avoided whenever possible.[4]

Once routes have been designed from the map, a personal survey should be conducted to observe any factors which might change them. After this survey, a time study should be made by driving over the route in equipment similar to or the same as that to be used in the actual operation. The driver(s) who will operate over the route should regard the trip as a dry run: all scheduled stops should be

[4] Recently, certain school districts have instructed drivers to retrace those certain routes where it was believed pupils were subjected to greater than ordinary hazards when crossing the road after alighting from the bus. In this manner, it is not necessary for the pupil to cross the particular highway.

made; live and dead mileage should be recorded; distance and time between stops should be indicated, etc. This data, if obtained accurately, will permit the development of a schedule which probably will need little revision once placed into effect. The schedule as finally established should allow the driver enough time to operate in a safe manner. Of course, allowances should be made for inclement weather conditions. In certain localities, it may be feasible to plan alternative routes in the event of road or bridge wash-outs and the like.

Descriptions of these routes and stops, along with schedules, then should be published in local papers. Similarly, parents and pupils should be notified by mail prior to the opening of school. A similar procedure should be followed when changes are made in the routes or schedules.

Each request for new or additional service should be investigated thoroughly prior to compliance. A glance at a map or the use of recall is a poor substitute for direct observation; personal investigation often reveals characteristics about the area that would make it unsatisfactory until certain revisions were effected.

A problem which often confronts the driver at the beginning of of the school year is the myriad of questions asked him, especially by anxious parents of pupils attending school for the first time. It is only natural that these questions arise and that they are directed toward the nearest representative of the board of education—in this case, the bus driver. But obviously a driver cannot maintain his schedule without being brusque to the parents or annoying motorists waiting behind him. Consequently, it is desirable to furnish the driver with cards he can hand to inquiring parents, inviting them to call or write the board of education. Naturally the mailing address and phone number are provided on such cards.

Use of High-Speed Thoroughfares

It should be remembered that the school bus, when operating on thoroughfares where relatively high speeds prevail, presents a hazard when stopped. If adequate secondary roads are available, it is usually unwise for buses to carry or discharge passengers on main arteries. Lacking adequate secondary roads, only a minimum number of stops

should be made along main traffic arteries. Such stops should be established only after thorough investigation has revealed the location to be the most desirable in the area. Some districts have built easements for buses to use, while others have instructed their drivers to take their vehicles completely off the hard surface road and onto the shoulder prior to loading or unloading. In these instances, the warning lights with which many areas equip their buses are not placed in operation and the motorist is not ordinarily required to stop when approaching from the front or from the rear. These procedures, while defensible in certain aspects, tend to confuse the motorist further as little uniformity exists in these practices among states or among districts within an individual state.

When crossing or entering main thoroughfares, it is recommended that the bus driver do so, as often as is practicable, at intersections where protection is afforded by traffic signs or signals.

It is considered poor practice when using a main artery to establish a route which calls for the driver to negotiate a "U-turn," despite the fact that the road may be a divided highway with provisions for such turns. Where the division or medial strip is too narrow to accommodate the length of the bus, the projection of the rear of the vehicle into the inside traffic lane as the driver awaits an opportunity to enter the traffic flow has been found to create traffic interference. Further, it is desirable to eliminate, insofar as it is possible, the necessity to turn the bus by backing; admittedly a bad practice with any vehicle, the dangers are increased with a long wheel-based vehicle such as a school bus.

Establishing Stops

In most states, a motorist is required to stop not less than a prescribed distance from a bus which is taking on or discharging passengers. For this reason, as well as others, consideration should be given to the location of bus stops. For example, stops should not be over the crest of a hill where the sight distance of the approaching motorist will not allow him to bring his vehicle to a stop at the prescribed distance from the bus; neither should stops be established around curves. Moreover, stops should be avoided on upgrades and downgrades of severe inclination, because the motorist may not be

able to stop in time. While the motorist is supposed to have his vehicle under control at all times, it is best to anticipate the worst.

When stopping along the highway, the driver should warn the motorist by reducing speed well before the stop, by using the signals with which the bus is equipped, and by fanning or pumping his brakes so that his stoplights flash. No stops should be sudden since every driver should know the route thoroughly; an exception, of course, would be an emergency situation. It also is recommended that stops be placed to avoid unnecessary disruptions to the normal flow of traffic. When traffic is relatively heavy, stopping the bus spasmodically often results in temporary traffic congestion. This situation is worsened in metropolitan areas where school hours frequently coincide with those of industrial and business employees.

In this connection, an arbitrary but successful method is to arrange stops not less than one-fourth mile apart (except, perhaps, for physically handicapped pupils). In this manner, traffic which may have piled up behind the bus will have an opportunity to pass the bus when it gets underway from a stopped position. Each stop should be established only after thorough investigation has revealed it to meet these and other specific criteria. If doubt exists in the mind of the school administrator making the survey, it is recommended that he consult the traffic engineering department of the state or county roads department, and utilize their special knowledge of the problem. The professional and competent services available through such an agency will minimize or possibly eliminate costly errors that otherwise might be committed.

Finally, each time a revision is made in an existing route, and each time additional stops are initiated, the bus schedule should be adjusted accordingly. Only after this procedure has been followed should an actual change be put into effect. Too often, changes are vague, ambiguous, word-of-mouth arrangements.

Certain states (Pennsylvania for example) have adopted a standard school bus stop sign which is installed along the streets and highways at specified locations. See Figure 2.

Other Aids to School Bus Operation

Another aid is that of establishing stops off heavily traveled thoroughfares. By looping around one or more blocks, the driver can

FIGURE 2. A standard school bus stop sign in use in the Commonwealth of Pennsylvania.

load or unload his cargo without seriously interrupting traffic. Moreover, such a practice removes many students from the immediate vicinity of heavily traveled thoroughfares. By such thorough planning, a minimum number of students will have to cross at busy intersections. Also, stops should be established at mid-block in urban areas so that approaching traffic will be able to negotiate a turn or cross the intersection and thereby clear the intersection for other traffic.

Generally, the number of pupils boarding a bus at a particular stop is not a serious problem. However, care should be exercised to assure that not too many pupils board the bus at any one stop or at any one time, because a long stop can easily congest normal traffic. More important, large numbers of children waiting and playing alongside the highway without supervision are a very real hazard.

The problem of waiting for late students is another factor which often complicates the traffic situation by annoying motorists. While a hard and fast rule is neither necessary nor desirable, a bus driver cannot wait for a late comer when a schedule has been established, publicized, and placed into operation. On the other hand, neither school buses nor public carriers can afford to operate ahead of schedule; rather, they should be on schedule. When at all practicable, routes should be laid out to require as few left turns as possible. A waiting vehicle, especially on a street where there is but one traffic lane in each direction, becomes a factor in temporary traffic congestion.

Each school should have a loading and unloading dock or area rather than discharge passengers on the street. At large consolidated schools, where buses may number from ten to forty or fifty, or even more, it is apparent that even with off-street docks or areas, traffic near the school will be congested at certain times of the day; therefore, these large physical plants should try to construct an interior road network on the school grounds, permitting buses to leave from one of several exits depending upon their ultimate destinations. Such an arrangement generally increases the flow of traffic in the vicinity of larger schools. Generally, buses should be designated as "expresses" or as "locals." Buses traveling the greatest distances should have priority in departing from the school grounds to permit a minimum of interruption on their schedules. Otherwise they would

have to stop behind "locals" which possibly would precede them out of the school grounds and onto the highway.

To be avoided also is the generally unnecessary and expensive practice of duplicating routes. Routes should be so designed and buses so scheduled as to make it unnecessary for more than one vehicle to cover a specified area. Primarily, the size of the area covered will depend upon the factors of distance and the numbers of pupils to be transported.

Effective routing does not have to wait on uniformity of traffic laws and ordinances; it is something that can be done *now,* through the cooperation of school officials, enforcement agencies and highways departments, to insure greater safety for our transported youth.

Driver Selection and Education

It is not uncommon for school districts, or other administrative jurisdictions having responsibility for driver procurement and supervision, to pay a driver less than the minimum hourly wage paid a day laborer in the area, despite the fact that his is one of the most important and most responsible of all tasks in education. As Kearney has stated:

> The man who drives a bus load of children to school every day, in all kinds of hazardous highway and weather conditions, is charged with grave responsibility. Together with a ship's captain, or an airline pilot, precious human lives depend upon his experience, skill and judgment. Yet, despite the increasing dangers of highway travel, many communities pay minimum attention to the dependability of their school bus drivers.[8]

Generally speaking, the qualities which make a good bus driver are not appreciably different from those of a good driver of any commercial vehicle. Yet few of the techniques of driver selection and education used in good fleet operations are observed in bus driver selection and education.

Little is really known about the optimal age at which an individual should be operating a school bus or about the optimal age at which he should be retired from such service. It appears, though, that physical, mental and emotional make-up should take precedence

[8] Paul W. Kearney, "Who Drives Your School Bus?" *Safety Education.* 33 (March, 1954), p. 5.

over chronological age, *per se*. A decided trend in evidence is the use of younger persons as drivers of school buses. However, no extensive data is available on the desirable upper age limits either of school bus drivers or of other drivers: this area needs investigation, because many individuals have taken to this profession upon retirement or semi-retirement.

While noteworthy efforts have been made in recent years toward improved selection procedures, much still remains to be done. Certain institutions of higher learning have started programs for preparing drivers both during summer school sessions and through field services rendered throughout the school year. North Carolina State College at Raleigh and New Mexico Western College at Silver City have made marked contributions in this area. In most other states, preparation has been done under the aegis of state motor vehicle, highway, or police departments.

North Carolina and some twenty other states have made extensive use of secondary school students as drivers for several years, and they have reported exceptionally favorable results. An examination administered by the state highway patrol supplements the preparation received through a standardized course set up and conducted by school authorities. Refresher programs, conducted by representatives of the state department of motor vehicles who work closely with school officials, continue throughout the student's tenure as a school bus operator. Highway patrolmen ride on each bus and over each route at least once each term, and observe driving performance, condition of the route, location of stops, and the like. Reportedly, the youth selected to drive buses throughout the state are well represented among honor students, class leaders, athletes, and other groups highly esteemed by fellow students.

While instructed to play an important role in maintaining the safety and operating efficiency of their vehicles, the student drivers are cautioned not to attempt to make repairs themselves; rather, they are requested to refer noted deficiencies to the garage in the area designated to service their particular vehicle.

In South Carolina, the state highway department is delegated the responsibility for educating drivers of school buses:

> Before being employed all prospective drivers shall be examined by the state highway department to determine their competency. The highway de-

partment is further directed to provide a rigid school bus driver training course and to issue special 'School Bus Driver's Certificates' to successful candidates. No person shall be authorized to drive a school bus in South Carolina in the process of transporting children, whether the bus be owned by the state, by a local school agency, or by a private contractor, who has not been certified by the state highway department . . .[8]

As is true in her sister state, state highway patrolmen and school officials attach considerable importance to the position. Concerted efforts are made to enlist the services of responsible leaders of the student population.

The use of student drivers is worthy of further investigation by school systems which are experiencing difficulties in procuring and retaining the services of qualified persons. Because of its part-time nature and its somewhat unusual hours, it is a job which does not attract many experienced, capable men.

While no authoritative data are available on the percentage of drivers of school buses who receive programs which equal or exceed those reported from North Carolina and South Carolina, it is believed that states which assume the responsibility for administering the program at the state level have the greater coverage with their programs. Many townships, districts, counties, and other administrative units have some requirements to which applicants for driving positions are subjected, largely of a surface variety: age, sex, educational level, general health, a valid driver's license, a good moral character and, in some instances, that the applicant be married and have one or more dependents.

Few districts have a person whose qualifications and work schedule permit the administration and interpretation of appraisal devices which reveal the individual's knowledge of recommended driving practices and his performance on a road test, or which give evidence of emotional qualifications. As a result, most of them settle for an individual who is physically fit according to a physician's examination and who meets the surface qualifications listed above.

No valid reason exists for supposing that applicants for positions as drivers of school buses should not be subjected to the same, or more extensive, examinations as are applicants for positions as operators of trucks, buses, or other carriers. These examinations should

[8] "Pupils Drive Buses in South Carolina," *Safety Education*. 32 (January, 1953), pp. 2–3.

include: a thorough physical examination by an authorized physician; prior driving experience as revealed by accidents or violations; an appraisal of his knowledge of recommended driving practices; a complete road test; an investigation of psychosocial factors, including marital status, relatives, educational level, job history, hospitalization record, civil and federal offense record (other than motor vehicle offenses) and general social behavior.

The value of investigation in predicting driving performance is a matter of record; those charged with the responsibility of selecting drivers for school bus operation would be remiss were they not to use these proven criteria in their personnel selection.

Once employed, the driver should be familiarized with his equipment, the area he will serve, the route(s) over which he will operate, the school(s) he will serve, the school officials with whom he will work, and the pupils he is to transport, as well as procedures to be followed in the event of an accident, road failure, inclement weather, emergency situation and the like. And naturally matters of salary, benefits, incentives and other policies which affect him should be thoroughly outlined and explained.

Once this has been accomplished, the task is *not over;* rather, it has just begun. Now it is necessary to direct adequate and proper supervision toward the driver, to provide for frequent observation, and to conduct in-service refresher and remedial programs for him.

The Pupil and Safe Transportation Practices

At a very early age and for the remainder of his life, an individual is transported to a variety of locations in a variety of conveyances. In view of this fact, it is important that educators seize upon and develop the excellent opportunities afforded them to teach safe and desirable practices among pupils who are transported. It is worth noting that the time spent on the bus each day by the average pupil is as much as—sometimes more than—he spends in any of his particular subjects.

The extent to which the factor of pupil control affects the performance of the individual driver is not known. But it is quite obvious that a properly disciplined group of passengers is highly desirable and conducive to safer driving. As a consequence, lectures

on child psychology and adolescent behavior should be a vital part of the courses for school bus drivers.

In addition to the control the driver is able to obtain, preferably through rapport with his passengers, other devices in the form of pupil patrols and faculty supervisors have been used. The objective of each is the same; to maintain order on the bus, and to prevent pupil injury through misbehavior or a vehicle collision attributable partially to diverted attention of the driver.

The primary objective of course is to educate the pupil in transportation practices which will result in his safety while being transported to and from school, but the possible transfer values of this education also should be considered. Instruction in such practices requires the cooperation of parent, pupil, driver, the administration and the teacher, and should be conducted both in the classroom and on the bus. Just where a particular facet should be taught depends upon where the objective can be more readily attained.

A limited number of excellent teaching aids, including films, film strips and slides, demonstrations, and paper and pencil quizzes, are available to supplement instruction. But it is quite unlikely that instruction in safe transportation practices will be effective if the equipment in which the pupils ride is not maintained properly, if the buses are overcrowded, and if the drivers are not selected and educated properly in their tasks. Safety instruction will be brought to fruition only in an atmosphere conducive to its growth and development. In fact, each phase of the safety program contributes to the success of other phases.

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